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Original Article

Evaluation of chest CT scan finding in the patients with acute respiratory symptoms following positive results of RT-PCR-COVID19

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Abstract: Background: Reverse transcription-polymerase chain reaction (RT-PCR) is a standard technique for diagnosing coronavirus disease 2019 (COVID-19). The parameters for the diagnosis of COVID-19 included the history of exposure to positive COVID-19 patients, clinical signs and symptoms related to the disease, inflammation factors in the blood test or positive antigen-antibody test, and chest computed tomography (CT) findings. The current study evaluated the chest CT scan findings in patients with respiratory problems following positive RT-PCR of COVID 19. Materials and methods: This cross-sectional study was performed on 120 patients referred to Ali Ibn-Abi Talib Hospital in Rafsanjan, Kerman Province, Iran, with respiratory symptoms between Dec-2019 to Dec-2020. Two radiologists reviewed the chest CT scans of these patients using the checklist that included parameters such as the types of involvement (consolidation/grand-glass/crazy paving, etc.) and the patterns of involvement (central/peripheral), and the pleural findings. Results: The CT scan was conducted in 107 patients with a typical condition and 11 patients with an atypical form of the disease. The frequency of the typical CT image of COVID-19 in the male group was significantly higher than that in the female group (P=0.004). The frequency of reverse halo sign, septal thickening, cardiomegaly, and crazy paving was significantly higher in males than in females (P≤0.05). Also, there was a significant difference between age groups based on the number of involved lobes (P=0.04). Conclusion: Chest CT scan is an important diagnostic method for COVID 19 with high sensitivity. The parameters in the CT scan are beneficial for the diagnosis of COVID 19. In addition, some characters in CT scans in the male gender are more specific.

Keywords: Chest CT, gender, age groups, COVID-19

Introduction

Although reverse transcription-polymerase chain reaction (RT-PCR) is a standard technique for diagnosis of COVID 19, the parameters for the diagnosis of COVID-19 include the history of exposure to the positive COVID-19 patient, clinical signs and symptoms related to the disease, inflammation factors in the blood test or positive antigen-antibody test, and chest computed tomography (CT) findings [1-5]. In the current emergency, the number of cases infected by COVID-19 increases with high incidence. Therefore, it is essential to identify all suspected cases as soon as possible to isolate them quickly and cut off the infection's source [3-11]. The recent studies have unveiled which chest CT is highly recommended for initial evaluation, management, and following up in the suspected COVID 19 due to early respiratory involvement [12-14]. The chest radiographs have little diagnostic values in the early stages, while CT findings may be present even before the onset of symptoms [15, 16]. In the moderate to advanced stages of the disease, chest radiographs may show the development of features of acute respiratory syndrome. In addition, CT findings are more specific for the diagnosis of COIVD-19 in cases with a false-negative of RT-PCR COVID-19 [13, 17]. In a study, 41 patients with COVID 19 were evaluated using Chest-CT scan, and imaging of the patients

showed lung lesions in all patients in chest-CT scan [18]. Based on Jin et al.'s study, CT scan findings in COVID 19 were valuable tools for determining stages of the disease [12]. The Song et al. study also reported that chest-CT scan findings in COVID-19 including, an increasing rate of irritating opacity, were related to disease progression [19]. The study results of Pan et al. concluded that more than 85% of patients with COVID-19 revealed CT-scan changes associated with the passage of the disease; these findings included increasing ground-glass opacities (GGO), stabilizing turbidity, and interstitial septal thickening [16]. In another study by Pan et al., the time courses of CT changes were shown in twenty-one confirmed cases of COVID-19. Higher GGO and fewer lobes involvement in the early stage of disease were revealed compared to subsequent scans in most patients [20]. The CT scan parameters for the diagnosis of COVID 19 in the adults include GGO, air space consolidation, crazy paving appearance (GGOs with septal thickening), traction bronchiectasis, bronchovascular thickening in the lesion, and subpleural sparing [21, 22].

With increasing global concerns about the prevalence of COVID 19, a thorough understanding of diagnostic imaging and abnormal features, and evolution of chest imaging findings are essential for the management and effective treatment of the patients. However, the information in various publications is scattered, and a full review of these findings has not yet been conducted. This study aimed to evaluate the results of chest CT scans in patients with suspected respiratory problems of COVID 19 referred to Rafsanjan-Iran.

Materials and methods

This cross-sectional study was performed on 120 patients referred to Ali Ibn-Abi Talib Hospital in Rafsanjan, Kerman, Iran, with respiratory symptoms from Dec 2019 to Dec 2020. The Research Ethics Committees approved the protocol of the current study of Rafsanjan University of Medical Sciences, and the ethics code is IR.RUMS.REC.1399.009. The CT scan was performed for the patients with respiratory symptoms and positive RT-PCR of COVID-19 within 24 hours. The high-resolution computed tomography (HRCT) scan of the lung was recommended by the Iranian Radiology Association (IRA) standard protocol with low dose HRCT, deep tail position, and the spiral method and without intravenous or oral contrast.

Chest CT scan of these patients was reviewed by two radiologists using the checklist that included parameters such as the types of involvement (consolidation/grand-glass/crazy paving, etc.) and the patterns of involvement (central/peripheral) pleural findings. Also, the mediastinal, liver, and spleen densities were extracted for fatty acid analysis.

All data of the current study were enrolled to SPSS software version 24. The mean and standard deviation were used to show quantitative variables and frequency, and percentage was used to describe qualitative variables. The study variables were compared between patients based on gender and age groups (1-59 years and >60 years). Therefore, the chi-square test was used to compare qualitative variables between groups, and the Independent t-test was adopted to compare quantitative data between groups. The significance level was considered as ≤ 0.05.

Results

In the current study, 120 patients, including 60 males and 60 females with a mean age of 55.05±17.48 years, were enrolled. The CT scan forms indicated 107 patients with the typical form and 11 patients with the atypical form of the disease. The CT scan findings and other information are summarized in **Table 1**.

The patients were divided based on gender, with no significant differences between the two genders based on age and the frequency of fatty liver, the number of involved lobes, and lung patterns ($P>0.05$). However, the frequency of typical CT scans in the male group was significantly higher than that in the female group ($P=0.004$). Also, the frequency of the reverse halo sign, septal thickening, cardiomegaly, and crazy paving was significantly higher in males than in females ($P\leq 0.05$), but there was no significant difference between genders regarding the halo sign, pleural effusion, lymphadenopathy, and pericardial effusion ($P>0.05$) (**Table 2**).

The variables were compared based on age groups, there was no significant difference between age groups based on the fatty liver,

Table 1. Clinical and imaging finding of patients

Variables			Frequency (n=120)	Percent
Fatty liver			16	13.4
Age group	1-59 year		72	60
	60<		48	40
CT scan form	Typical		107	89.2
	Atypical		11	9.2
CT scan Finding	Cons		78	65
	GGO		115	95.8
	Crazy paving		38	31.7
	Halo sign		17	14.2
	Reverse Halo Sign		14	11.7
	Cavity		1	0.8
	Nodule		13	10.8
	Bronchiectasis		2	1.7
	Septal thickening		62	51.7
	Air Bronchogram		29	24.2
	Emptysem		13	10.8
	Cyst		6	5
	Bronchial wall thickening		1	0.8
	Fibrotic band		1	0.8
	Atelectasis		14	11.7
	RUL involvement		99	82.5
	RML involvement		84	70
	RLL involvement		114	95
	LUL involvement		96	80
	LLL involvement		110	91.7
	Lingula		48	40
	Pleural effusion		8	6.7
	PE side	Right	3	2.5
		Both	5	4.2
	Pleural thickening		42	35
	PT side	Right	10	8.3
		Left	9	7.5
		Both	23	19.2
	Lymphadenopathy		30	25
	Pericardial Effusion		2	1.7
	Cardiomegaly		34	28.3
			Mean	SD
Age (mean ± SD) (year)			55.05	17.48
Number of Involved lobes (mean ± SD)			4.59	1.42

GGO: ground-glass opacities, CT: computed tomography, RUL: right upper lobe, RML: right middle lobe, RLL: right lower lobe, LUL: left upper lobe, LML: left middle lobe, LLL: left lower lobe, PE: Pleural effusion, PT: Pleural thickening.

lung pattern, and CT scan forms (P>0.05), but there was a significant difference between age grouping based on the number of involved lobes (P=0.04) (**Table 3**).

Discussion

Based on the current study results, the frequency of typical CT scan form was higher in males than in females. Also, the frequency of reverse halo sign, septal thickening, cardiomegaly, and crazy paving was higher in males than in females. Therefore, changing chest CT image was associated significantly with genders in patients with COVID 19.

Jin et al. evaluated Chest CT scan images of COVID 19, so the authors described that the disease is in five-time stages, including extremely premature, premature, rapid progression, integration, and dissipation. In the highly early stage (asymptomatic, 1-2 weeks after exposure), CT may show focal GGO of one or more foci, spotty stabilizing opacities, GGO-enclosed pulmonary nodules, and aerial bronchograms. In the early stage or premature (presenting with early symptoms, 54% of cases), CT scan findings include single or multiple GGOs or GGOs with thickening of the interlobular vertebra. In the rapid progression phase (days 3 to 7 onset of symptoms), CT scan findings include significant turbidity, irritating style, and air bronchogram. About 2-3 weeks after start of disease, a CT scan may show fragmented opacities, retinal detachments (called 'strip-like opacities'), bronchial wall thickening, and interlobular vertebral thickening [12]. In our study, the incidences of GGO, septal thickness, crazy paving, air bronchogram, halo sign, and reverse halo sign were higher than other CT scan findings in the early stage of disease, respectively.

A study by Pan et al. evaluated preliminary findings of CT and temporal changes in patients with COVID-19. In this study, 63 definitive patients were enrolled from

Table 2. Variables of study based on gender

Variables		Gender		*P*-value
		Male	Female	
Age		53.42±17.53	56.68±17.42	0.30*
Fatty liver		7 (11.7%)	7 (11.7%)	<0.99**
Number of Involved lobes		4.82±1.32	4.37±1.50	0.08*
Lung Pattern	Peripheral	35 (58.3%)	35 (58.3%)	<0.99**
	Peripheral and Central	25 (41.7%)	25 (41.7)	
CT scan form	Typical	59 (98.3%)	48 (82.8%)	0.004**
	Atypical	1 (1.7%)	10 (17.2%)	
CT scan Finding	Halo sign	10 (16.7%)	7 (11.7%)	0.60**
	Reverse Halo Sign	11 (18.3%)	3 (5%)	0.04**
	Septal Thickening	40 (66.7%)	22 (36.7%)	0.002**
	Plural Effusion	3 (5%)	5 (8.3%)	0.71**
	Lymphadenopathy	12 (20%)	18 (30%)	0.29**
	Pericardial effusion	1 (1.7%)	1 (1.7%)	>0.99**
	Cardiomegaly	10 (16.7%)	24 (40%)	0.008**
	Crazy paving	29 (48.3%)	9 (15%)	<0.001**

*Independent t test, **Chi Square. CT: computed tomography.

Table 3. Variables of study based on age grouping

Variables		Aged groups		*P*-value*
		1-59 year	>60 year	
Fatty liver		10 (13.9%)	4 (8.3%)	0.40
Lung Pattern	Peripheral	47 (65.3%)	23 (47.9%)	0.08
	Peripheral and Central	25 (34.7%)	25 (52.1%)	
CT scan form	Typical	66 (93%)	41 (87.2%)	0.34
	Atypical	5 (7%)	6 (12.8%)	
Number of Involved lobes	1	4 (5.6%)	1 (2.1%)	0.04
	2	5 (6.9%)	0	
	3	14 (19.4%)	5 (10.4%)	
	4	14 (19.4%)	5 (10.4%)	
	5	15 (20.8%)	14 (29.2%)	
	6	20 (27.8%)	23 (47.9%)	

*Chi Square, CT: computed tomography.

December 30, 2019, to January 31, 2020. The patients underwent a high-resolution CT scan (HRCT). The number of affected lobes, ground-glass nodules, the presence of patchy/punctate ground-glass opacities, patchy consolidation, fibrous stripes, and irregular masses was recorded in the chest image of each patient. The mean of the number of involvement of the lobes was 3.3±1.8. The number of involved lobes included 19 patients (30.2%) with one lobe, five patients (7.9%) with two lobes, four patients (6.3%) with three lobes, seven patients (11.1%) with four lobes, and 28 patients (44.4%) with five lobes involvement. In terms of different lesions, the frequency of patchy/punctate ground-glass opacities was 54 (85.7%), the frequency of ground-glass nodules was 14 (22.2%), the frequency of patchy consolidation was 12 (19%), the frequencies of fibrous stripes and irregular chest masses were 11 (17.5%) and 8 (12.7%), respectively [16]. In our study, the mean of involved lobes was 4.59±1.42, and also the frequencies of OGG, nodule, and the fibrotic band were 95.8%, 10.8%, and 0.8%, respectively.

In a case report by Huang et al., who evaluated chest CT of a COVID19 patient with high clinical symptoms suspected to COVID 19 and a negative RT-PCR of COVID-19 test. In this study, a

36-year-old man was referred to the hospital five days after the presence of symptoms, and the patient had a 2-day history of fever, sore throat, and fatigue. The patient's body temperature was 37.8°C at admission. The cardiac and lung examinations were normal. Lab data showed a normal white blood cell count (4.9×10^9) with neutrophil dominant (53.1%), and also blood procalcitonin levels were normal. Chest CT showed multiple lesions of GGOs in both lungs with more involvement of the left upper lobe (the lingular section). However, RT-PCR was negative at the time of admission [13]. Based on our results, CT scan was a specific procedure for diagnosing suspected patients with COVID-19 in the early stage of respiratory symptoms, and GGOs are more prevalent in the patients.

A study by Xie et al. evaluated the association between Chest CT parameters and negative RT-PCR of COVID-19 in suspected patients. This study evaluated five patients with the negative initial RT-PCR test using HRCT. CT scan findings included 5 cases with GGOs and 2 cases with GGOs and mixed consolidation lesions. Finally, all patients were positive for COVID 19 with repeated swab tests. Therefore, based on the findings of this study, it can be concluded that a combination of repeated swab tests and CT scans may be helpful in people with high clinical suspicion and an initial negative RT-PCR test [17]. In our study, the results indicated CT scan findings used diagnose COVID 19, similar to RT-PCR.

In Song et al.'s study, chest CT scans of the patients with COVID-19 were evaluated, and CT scan findings were included 77% GGOs and 75% GGOs with lobular thickening. GGOs and consolidation were observed in 59% of cases, and consolidation alone was observed in 55%. Bilateral involvements of lungs were observed in 86% of cases, the posterior involvement of the lungs was observed in 80% cases, and peripheral involvement of the lungs was shown in 86%. More pulmonary lesions were observed in infected patients for more than five days ($P<0.001$). The patients over 50 years had more lung lesions than younger people ($P<0.001$). Based on the findings of this study, patients with relevant symptoms, positive lung lesions based on CT, and normal or decreased white blood cells are more likely to develop the disease [19]. In our study, there was a direct relationship between age, and the number of involved lobes and also GGOs were the most prevalent parameter in the patients.

Pan et al. evaluated the severity of lung involvement scores based on Chest CT in the COVID-19 patients. The total score of the CT scan was determined based on the degree of lung involvement (5 lobes, score 1-5 for each involved lobe, total score range was between zero and 25). The maximum lung involvement was observed ten days after initial symptoms. Four stages were defined based on the defined quartiles that were included the first stage (days 0 to 4) of ground-glass opacities in 75% of cases with mean CT score (2±2), the second stage (days 5 to 8) increased crazy-paving pattern view in 53% of patients with mean CT score (4±6), third stage (days 9 to 13) consolidation view in 91% with mean CT score (4±7) and fourth stage (14 days and above) gradual resolution of consolidation was observed in 75% of cases with mean CT score (4±6). According to the findings of this study, in the recovery period (without severe respiratory distress during the disease), lung abnormalities in the chest CT-scan showed the greatest severity approximately ten days after the onset of initial symptoms [20]. The evaluating severity of disease based on scoring is a suitable method for the progression of the disease.

In a study by Lei et al., a 33-year-old woman with a 5-day history of fever and cough was referred to the hospital for an unknown reason. The patient has worked in Wuhan, China, and traveled to Lanzhou six days before the hospital admission. His body temperature was 39 degrees, and wheezing was heard in both lungs at the time of admission. Laboratory studies showed leukopenia. The white blood cell count examination showed 70% neutrophils and 0.1% eosinophils. High blood levels were reported for protein C reaction level (16.16 mg/L), erythrocyte sedimentation rate (29 mm/h). Unbalanced chest CT, multiple peripheral ground-glass opacities were observed in both lungs. Finally, RT-PCR COVID 19 test 7 was positive [23]. Based on the results of our study, a CT scan is a specific method for diagnosis of early respiratory involvement in the suspected patients to COVID-19 with negative or positive RT-PCR COVID-19 test. The current study's limitations

included the lack of considering the suspected patients with negative RT-PCR COVID-19 and low sample size.

Conclusion

Based on the current study results and other studies about Chest CT scan in COVID 19, chest CT scan is an important diagnostic method for the early identification of suspected COVID 19 patients with respiratory involvement with high sensitivity and specificity. Also, some characters in the CT scan were specific to diagnosis of COVID 19, and some characters in the male gender were more prevalent.

Disclosure of conflict of interest

None.

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