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Differentiation of Chest CT Findings Between Influenza Pneumonia and COVID-19: Interobserver Agreement Between Radiologists

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Objectives: To investigate the chest CT and clinical characteristics of COVID-19 pneumonia and H1N1 influenza, and explore the radiologist diagnosis differences between COVID-19 and influenza.

Materials and methods: This cross-sectional study included a total of 43 COVID-19-confirmed patients (24 men and 19 women, 49.90 ± 18.70 years) and 41 influenza-confirmed patients (17 men and 24 women, 61.53 ± 19.50 years). Afterwards, the chest CT findings were recorded and 3 radiologists recorded their diagnoses of COVID-19 or of H1N1 influenza based on the CT findings.

Results: The most frequent clinical symptom in patients with COVID-19 and H1N1 pneumonia were dyspnea (96.6%) and cough (62.5%), respectively. The CT findings showed that the COVID-19 group was characterized by GGO (88.1%), while the influenza group had features such as GGO (68.4%) and consolidation (66.7%). Compared to the influenza group, the COVID-19 group was more likely to have GGO (88.1% vs. 68.4%, $p = 0.032$), subpleural sparing (69.0% vs. 7.7%, $p < 0.001$) and subpleural band (50.0% vs. 20.5%, $p = 0.006$), but less likely to have pleural effusion (4.8% vs. 33.3%, $p = 0.001$). The agreement rate between the 3 radiologists was 65.8%.

Conclusion: Considering similarities of respiratory infections especially H1N1 and COVID-19, it is essential to introduce some clinical and para clinical modalities to help differentiating them. In our study we extracted some lung CT scan findings from patients suspected to COVID-19 as a newly diagnosed infection comparing with influenza pneumonia patients.

Key Words: Influenza pneumonia; H1N1; COVID-19; CT scan; Respiratory tract infection.

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INTRODUCTION

A cluster of pneumonia-infected patients of unexplained etiology appeared in December 2019, known as coronavirus disease 2019 (COVID-19) in China (1,2). A total of 131,580,761 COVID-19-confirmed cases and 2,862,510 death cases had been reported by the World Health Organization (WHO) up to April 04, 2021 (3-9). Considering the growing number of infected and dead cases, the early diagnosis of novel coronavirus has become a matter of utmost urgency. Even though reverse

transcriptase-polymerase chain reaction (RT-PCR) is the reference standard tool to confirm the diagnosis of COVID-19 pneumonia, a large number of false-negative/positive RT-PCR results have recently been observed (10,11), making the diagnosis rather challenging. Chest CT is currently considered as one of the best methods for early diagnosis which contributes to distinguishing the disease severity, and prognosis of COVID-19 infection (12).

It is notable that there are several types of respiratory infectious diseases like COVID-19 and H1N1 pneumonia that their chest CT characteristics may differ (13). Accordingly, when assessing COVID-19, one must note that it shares common etiologies with and occurs in the same season as do influenza viruses (14). Influenza virus infections are widespread worldwide and cause a high rate of morbidity and mortality (15). They are divided into 4 groups (A, B, C, and D), with epidemics of seasonal flu due to influenza A and B (16). H1N1 is an influenza A virus subtype that contributes to respiratory infections and has generated 2 pandemics in the last century (17,18).

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Additionally, given some identical clinical symptoms between H1N1, and COVID-19 pneumonia (19), it is essential for radiologists to clarify the differences between the 2 respiratory tract viruses on the basis of radiological manifestations. Therefore, we made an effort to compare the differences between the chest CT findings for H1N1 virus infection and those of COVID-19 in order to provide some guidance for their differential diagnoses. Moreover, another aim of the present study was to assess the interobserver variability between chest radiologists in the evaluation of chest CT scans in patients suspected to COVID-19 infection.

METHODS

Participant Criteria and Study Design

In this cross-sectional and multi-center study, acute respiratory distress syndrome (ARDS) patients suspected to COVID-19 and H1N1 pneumonia were screened. We included all confirmed COVID-19 cases who were admitted from March 1 to July 20 at the isolation ward of Ali Asghar, Faghihi, and Namazi Hospitals of Shiraz University of Medical Sciences, Shiraz, Iran. Based on the positive results by real-time RT-PCR, patients were divided into COVID-19 ($n = 43$) and H1N1 ($n = 41$) groups. Chest CT was carried out for the diagnosis of pneumonia. All patients undergone chest CT within the first 24 hours' admission time. The study was performed in compliance with the principles of the *Declaration of Helsinki* and obtained the approval of the Ethics Committee of Shiraz University of Medical Sciences, Shiraz, Iran (IR.SUMS.REC.1399.120). The informed consent was waived because this study was retrospective and thus posed no potential risk to patients.

CT Scanning Protocol

All patients underwent scanning with the following scanners: 128-MDCT Philips Ingenuity (Philips healthcare, United States), 2-MDCT Siemens (Somatom Volume Zoom, Siemens, Forchheim, Germany), 4-MDCT GE (Bright Speed, GE Healthcare, Milwaukee, WI), and 2-MDCT Siemens (Somatom Definition, Siemens, Forchheim, Germany) with 120-130 kVp, 7-250 mAs, tubal current 119-515, Pitch 1.2-1.6, slice thickness 0.625-1.2 mm, and reconstruction thickness of 1-5. All patients were in supine position, performing a breath-hold after inhalation. The scanning range was from bilateral apex to base.

Image Viewing and Evaluation

Two radiologists with more than 5 years' experience in chest imaging analyzed all CT images independently. If there was any inconsistency, they reached an agreement through discussion, presenting scientific arguments. A third radiologist (25 years of experience in pulmonary imaging diagnosis) reviewed all CT findings for confirmation.

The predominant patterns seen on CT images were classified into 3 major categories: Lung, bronchial, and pleural changes. Each major category was divided into subcategories. Lung changes were classified into the following 9 subcategories: Ground-glass opacities (GGO; increased attenuation without obscuration of the underlying lung vessels), consolidation (homogeneous increased intensity of lung parenchyma with obscuration of the underlying vessels), crazy paving (GGO with septal thickening), reverse halo (central GGO surrounded with more dense consolidation), tree-in-bud pattern (centrilobular nodules with a linear branching pattern), centrilobular nodule, solid nodule (well defined and >3 mm), subpleural sparing (Subpleural Lines. These 5- to 10-cm-long curvilinear opacities are found within 1 cm of the pleura and parallel the chest wall. They are most frequent in the posterior portions of the lower lobes and remain unchanged on prone scans. They probably represent an early phase of lung fibrosis and should be distinguished from a similar line that is seen as a result of atelectasis in the dependent portion of the lungs in normal individuals. Subpleural lines are most often seen in patients with asbestosis and, less commonly, IPF.), subpleural band (Parenchymal bands are non-tapering linear opacities, 2 to 5 cm in length, that extend from the lung to contact the pleural surface. These fibrotic bands can be distinguished from vessels and thickened septa by their length, thickness, course, absence of branching, and their association with regional parenchymal distortion. Parenchymal bands are frequently seen in asbestosis, IPF, and sarcoidosis.), Bronchial changes were classified into 4 subcategories: Air bronchogram (an air-filled image of bronchus in lung lesions), bronchiectasis [an irreversible abnormal dilatation of the bronchial tree], air trapping [refers to retention of excess gas ("air") in all or part of the lung; Specially during expiration, either as a result of complete or partial airway obstruction or as a result of local abnormalities in pulmonary compliance.] and bronchus distortion. Pleural changes were classified into 2 subcategories: Thickening of the pleura and pleural effusion. Distribution of the lung lesions was classified as predominantly peripheral (involving mainly the peripheral region comprising one-third of the lung), central (involving mainly the central region comprising two-thirds of the lung), or peribronchovascular pattern (along with bronchovascular bundle) and diffuse. Each side of the lung was divided (from top to bottom) into 3 zones: The upper zone (above the carina), the middle zone (from the carina to the inferior pulmonary vein), and the lower zone (below the inferior pulmonary vein). Each zone was then divided into 2 areas: The anterior area (the area before the vertical line of the midpoint of the diaphragm in the sagittal position) and the posterior area (the area after the vertical line of the midpoint of the diaphragm in the sagittal position). Finally, each lung was divided into 12 zones and the degree of involvement in each lung zone was scored as follows: A score of 0 denoted no involvement; 1, $< 25\%$ involvement; 2, 25% to less than 50% involvement; 3, 50% to less than 75% involvement; and 4, $\geq 75\%$ involvements.

Scores were recorded and summed for each lung zone, with a maximum possible score of 48.

Statistical Analysis

To perform statistical analysis of the data, the SPSS Statistics 23.0 software (SPSS Inc., Chicago, Illinois, USA) was used. The distribution of data normality was examined by the Kolmogorov-Smirnov test. Moreover, numerical variables were expressed as mean \pm standard deviation (SD) and were analyzed by means of the Independent sample t-test/Mann-Whitney U test. Categorical variables were reported by counts and percentages and evaluated by χ^2 test/Fisher's exact tests. Pairwise agreement between the radiologists were determined by kappa coefficient. A value of $P < 0.05$ was considered statistically significant.

RESULTS

The comparison of demographic, clinical, and laboratory features of the patients infected with COVID-19 and H1N1 pneumonia is shown in Table 1. Among patients with H1N1 pneumonia, 46.2% had diabetes mellitus, and 38.5% had hypertension, while this percentage was 10.3% and 3.4% for patients with COVID-19, respectively. Of 84 patients included in this study, 43 patients were SARS-CoV-2 positive and 41 patients were infected with H1N1 pneumonia. The mean age values for patients with COVID-19 and H1N1 pneumonia were 49.90 ± 18.70 and 61.53 ± 19.51 , respectively ($p = 0.051$). Although 12 COVID-19 patients (41.4%) were admitted to ICU, none of the patients with H1N1 pneumonia were admitted to ICU ($p = 0.002$). The most common symptoms in COVID-19 patients were dyspnea (96.6%), cough (93.1%), and fatigue (89.3%) respectively, while the most common symptoms in influenza patients were cough (62.5%), dyspnea (37.5%), and chills (35.3%). Among the clinical symptoms, cough ($p = 0.017$), dyspnea ($p < 0.001$) and fatigue ($p < 0.001$) were significantly higher in COVID-19 patients. Meanwhile, chills ($p = 0.007$), hemoptysis ($p = 0.045$) and orthopnea ($p = 0.045$) were higher in influenza patients than in those with COVID-19. About 32% of COVID-19 and 29% of influenza patients were shown to have comorbidities, of which diabetes mellitus and ischemic heart disease were the most common, followed by hypertension. Diabetes mellitus (6/3, $p = 0.016$) and hypertension (5/1, $p = 0.007$) were indicated to be more common in influenza patients than in COVID-19 patients. Regarding inflammatory factors including CRP and ESR, there were no significant differences between the COVID-19 and H1N1 groups (CRP: 34.33 ± 20.78 and 74.83 ± 62.06 and ESR: 36.54 ± 20.65 and 33.25 ± 30.90 , respectively ($p = 0.175$ and 0.806 , respectively). A significantly higher temperature level was seen in the COVID-19 patients (38.51 ± 0.41) than in the influenza patients (36.93 ± 0.90) ($p = 0.004$).

Table 2 depicts the comparison of chest CT features between COVID-19 and influenza patients, showing GGO (88.1%), subpleural sparing (69.0%) and subpleural band (50.0%) as the most prevalent CT findings in COVID-19 patients, and GGO (68.4%) and consolidation (66.7%) as the most prevalent CT findings in influenza patients. The 2 groups did not differ in terms of crazy paving, consolidation and atoll sign (reversed halo sign) ($p = 0.851$, 0.273 , and >0.999 , respectively). Nonetheless, COVID-19 patients had higher GGO ($p = 0.032$), subpleural sparing ($p = <0.001$) and subpleural band ($p = 0.006$) chest CT manifestations in comparison to influenza patients.

Of all 84 cases examined by radiologists, the agreement rate between the 3 radiologists were 65.8%. Also, all 3 radiologists recorded their diagnoses on 72 patients, of whom 50 yielded similar diagnoses wherein 33 (39.3%) were identified as COVID-19 and 15 (17.9%) as H1N1 pneumonia (Table 3). The H1N1 or COVID-19 diagnosis of each radiologist is given in Table 3. As shown in Table 4, the degree of agreement between the diagnoses by either radiologist was significant for the pairwise condition ($P < 0.001$). The values for the degree of agreement (kappa) between the first and second radiologists, the first and third, and the second and third radiologists were 0.419, 0.584, and 0.587, respectively.

DISCUSSION

As a global health warning introduced by WHO, the widespread COVID-19 pandemic has begun to turn into a new challenge with regard to determining the early diagnosis, isolation, and optimal treatment (2,20-22). RT-PCR as a laboratory technique and confirmed 1 is not empty of false-negative reports according to numerous reasons (23). Therefore, in those highly suspicious patients with negative RT-PCR results, thin-section CT features could be considered as paramount guidance (10,24,25). On the other hand, according to seasonal climate changes, respiratory tract viruses such as influenza and respiratory syncytial viruses tend to involve bronchus, lung parenchyma, and also pleura.

Given the overlapping of clinical manifestations and laboratory findings of COVID-19 and H1N1 pneumonia (14), the present study compared the chest CT and clinical features of patients infected with SARS-CoV-2 and H1N1 to see what exactly are their differences. It was found that COVID-19 patients had more GGO, subpleural sparing, and also subpleural bands, whereas patients with influenza developed more consolidation and pleural effusions manifestations. However, no significant difference was detected in terms of CT scores between the 2 groups. Considering laboratory data, leukocytosis was more common in H1N1 group, although COVID-19 patients showed significantly higher body temperatures in the course of their disease. Also, COVID-19 patients were clinically wearier and more dyspneic than H1N1 ones and had more cough regardless of lung involvement distribution.

TABLE 1. Comparison of Clinical and Laboratory Features Between COVID-19 and H1N1 Confirmed Patients

Variable	COVID-19		H1N1		p-value	
	N	Mean \pm SD/N(%)	N	Mean \pm SD/N(%)		
Age, Y	29	49.90 \pm 18.70	17	61.53 \pm 19.51	0.051	
Sex	Male	43	24 (55.8%)	41	17 (41.5%)	0.188
	Female		19 (44.2%)		24 (58.5%)	
ICU	Yes	29	12 (41.4%)	17	0 (0.0%)	0.003
	No		17 (58.6%)		17 (100.0%)	
Hospital Duration (day)	27	7.26 \pm 4.29	9	13.00 \pm 15.33	0.186	
Smoker	Yes	28	4 (14.3%)	18	2 (11.1%)	0.131
	No		24 (85.7%)		16 (88.9%)	
Cough	Yes	29	27 (93.1%)	16	10 (62.5%)	0.017
	No		2 (6.9%)		6 (37.5%)	
Dyspnea	Yes	29	28 (96.6%)	16	6 (37.5%)	<0.001
	No		1 (3.4%)		10 (62.5%)	
Fatigue	Yes	28	25 (89.3%)	16	1 (6.3%)	<0.001
	No		3 (10.7%)		15 (93.8%)	
Chest Pain	Yes	29	0 (0.0%)	17	2 (11.8%)	0.131
	No		29 (100.0%)		15 (88.2%)	
Chills	Yes	29	1 (3.4%)	17	6 (35.3%)	0.007
	No		28 (96.6%)		11 (64.7%)	
Hemoptysis	Yes	29	0 (0.0%)	17	3 (17.6%)	0.045
	No		29 (100.0%)		14 (82.4%)	
Weight Loss	Yes	29	1 (3.4%)	17	0 (0.0%)	>0.999
	No		28 (96.6%)		17 (100.0%)	
Ear Pain	Yes	29	1 (3.4%)	17	0 (0.0%)	>0.999
	No		28 (96.6%)		17 (100.0%)	
Malaise	Yes	29	2 (6.9%)	17	1 (5.9%)	>0.999
	No		27 (93.1%)		16 (94.1%)	
Orthopnea	Yes	29	0 (0.0%)	17	3 (17.6%)	0.045
	No		29 (100.0%)		14 (82.4%)	
Weakness	Yes	29	1 (3.4%)	17	2 (11.8%)	0.545
	No		28 (96.6%)		15 (88.2%)	
Dizziness	Yes	29	0 (0.0%)	17	2 (11.8%)	0.131
	No		29 (100.0%)		15 (88.2%)	
Epigastric Pain	Yes	29	0 (0.0%)	17	1 (5.9%)	0.370
	No		29 (100.0%)		16 (94.1%)	
ESR (mm/hr)	13	36.54 \pm 20.65	4	33.25 \pm 30.90	0.806	
CRP (mg/L)	12	34.33 \pm 20.78	6	74.83 \pm 62.06	0.175	
Hb (g/dL)	29	13.56 \pm 1.53	14	12.71 \pm 3.43	0.390	
AST (U/L)	18	46.61 \pm 33.93	1	42.00 \pm 0.0	0.647	
LDH (U/L)	10	585.30 \pm 237.45	6	1192.50 \pm 866.74	0.193	
O ₂ Saturation (%)	2	93.00 \pm 2.83	10	81.70 \pm 13.54	0.284	
WBC (10 ⁹ /L)	29	6.837 \pm 3.405	14	10.142 \pm 3.896	0.006	
Temperature (°C)	26	38.51 \pm 0.41	3	36.93 \pm 0.90	0.004	
Antiviral Drug	Yes	29	26 (89.7%)	16	0 (0.0%)	<0.001
	No		3 (10.3%)		16 (100.0%)	
Antibacterial Drug	Yes	29	27 (93.1%)	17	8 (47.1%)	0.001
	No		2 (6.9%)		9 (52.9%)	
Comorbidity	Yes	43	14 (32.6%)	41	12 (29.3%)	0.744
	No		29 (67.4%)		29 (70.7%)	
Comorbid Diabetes Mellitus	Yes	29	3 (10.3%)	13	6 (46.2%)	0.016
	No		26 (89.7%)		7 (53.8%)	
Comorbid Hypertension	Yes	29	1 (3.4%)	13	5 (38.5%)	0.007
	No		28 (96.6%)		8 (61.5%)	
Comorbid Ischemic Heart Disease	Yes	29	4 (13.8%)	13	4 (30.8%)	0.226
	No		25 (86.2%)		9 (69.2%)	

Values are expressed as number and percent for categorical variables and, mean and standard deviation for continuous ones.

TABLE 2. Comparison of Chest CT Features Between COVID-19 and H1N1 Confirmed Patients

Variable		COVID-19		H1N1		p-value
		N	%	N	%	
GGO	Yes	37	88.1%	26	68.4%	0.032
	No	5	11.9%	12	31.6%	
GGO Single	Yes	2	5.0%	3	7.9%	0.671
	No	38	95.0%	35	92.1%	
GGO Multiple	Yes	34	81.0%	21	53.8%	0.009
	No	8	19.0%	18	46.2%	
GGO Peripheral	Yes	35	83.3%	23	59.0%	0.015
	No	7	16.7%	16	41.0%	
GGO Central	Yes	14	34.1%	14	36.8%	0.802
	No	27	65.9%	24	63.2%	
GGO Irregular	Yes	30	71.4%	25	64.1%	0.480
	No	12	28.6%	14	35.9%	
GGO Round	Yes	11	26.8%	8	20.5%	0.507
	No	30	73.2%	31	79.5%	
GGO Diffuse	Yes	2	4.8%	2	5.1%	>0.999
	No	40	95.2%	37	94.9%	
Crazy Paving	Yes	6	14.3%	6	15.8%	0.851
	No	36	85.7%	32	84.2%	
Consolidation	Yes	23	54.8%	26	66.7%	0.273
	No	19	45.2%	13	33.3%	
Consolidation Single	Yes	3	7.1%	1	2.7%	0.618
	No	39	92.9%	36	97.3%	
Consolidation Multiple	Yes	19	45.2%	24	61.5%	0.142
	No	23	54.8%	15	38.5%	
Consolidation Peripheral	Yes	22	52.4%	23	59.0%	0.551
	No	20	47.6%	16	41.0%	
Consolidation Central	Yes	8	19.0%	6	15.8%	0.702
	No	34	81.0%	32	84.2%	
Consolidation Irregular	Yes	22	52.4%	20	51.3%	0.921
	No	20	47.6%	19	48.7%	
Consolidation Round	Yes	4	9.5%	4	10.5%	>0.999
	No	38	90.5%	34	89.5%	
Consolidation Diffuse	Yes	0	0.0%	1	2.6%	0.475
	No	42	100.0%	37	97.4%	
Consolidation Upper	Yes	6	14.3%	10	25.6%	0.200
	No	36	85.7%	29	74.4%	
Consolidation Both	Yes	6	14.3%	9	23.1%	0.309
	No	36	85.7%	30	76.9%	
Consolidation Lower	Yes	10	23.8%	20	51.3%	0.011
	No	32	76.2%	19	48.7%	
Subpleural Sparing	Yes	29	69.0%	3	7.7%	<0.001
	No	13	31.0%	36	92.3%	
Atoll Sign (Reversed halo sign)	Yes	2	5.0%	2	5.1%	>0.999
	No	38	95.0%	37	94.9%	
Subpleural Band	Yes	21	50.0%	8	20.5%	0.006
	No	21	50.0%	31	79.5%	
Bronchiectasis	Yes	1	2.4%	4	10.3%	0.191
	No	41	97.6%	35	89.7%	
Air Trapping	Yes	1	2.4%	6	15.4%	0.052
	No	41	97.6%	33	84.6%	
Air Bronchogram	Yes	14	34.1%	19	48.7%	0.186
	No	27	65.9%	20	51.3%	
Pleural Effusion	Yes	2	4.8%	13	33.3%	0.001
	No	40	95.2%	26	66.7%	

(continued)

TABLE 2. (Continued)

Variable		COVID-19		H1N1		p-value
		N	%	N	%	
CT Score	Mild	14	37.8%	5	26.3%	0.106
	Moderate	17	45.9%	6	31.6%	
	Severe	6	16.2%	8	42.1%	

Values are expressed as number and percent. GGO, ground glass opacity.

TABLE 3. The Number of Patients That Diagnosed As COVID-19 or H1N1 By 3 Radiologists

	Diagnosis	N (%)
Radiologist 1	COVID-19	54 (64.3%)
	H1N1	28 (33.3%)
	Total	82 (97.6%)
Radiologist 2	COVID-19	39 (46.4%)
	H1N1	36 (42.9%)
	Total	75 (89.3%)
Radiologist 3	COVID-19	50 (59.5%)
	H1N1	33 (39.3%)
	Total	83 (98.8%)
Identical Diagnosis by All 3 Radiologists*	COVID-19	33 (39.3%)
	H1N1	15 (17.9%)

* The number of cases that all 3 radiologists diagnosed as one.

Focusing on common areas of lung involvements, peripheral tendency and multiple lesions pattern have been shown to be the most frequent CT features in COVID-19 patients with prevalence of 83.3% and 81%, respectively, in the present study. These results are inconsistent with previous coronavirus infection surveys like SARS, specially reported in recent studies (3,4). Also, according to the studies by Koo et al. and Miller et al. (26,27), patients with influenza, especially H1N1 types, are more prone to the lung lower-lobe involvement as witnessed in the present study. They also showed that consolidation, as a common finding in patients with

H1N1 pneumonia, had a higher frequency in lower segments of the lung than in those of COVID-19 patients (51.3% versus 23.8%, respectively) (14). GGO and consolidation are 2 prevalent findings in chest CT of patients with bacterial pneumonia that commonly are seen significantly in both COVID-19 and influenza patients as well. However, this study revealed that COVID-19 patients had higher rates of GGO than patients with influenza. The pattern of GGO involvement was also significantly different from the more peripheral trend of injury in COVID-19 patients. Each of the previously mentioned findings determine and reflects nothing by itself and does not contribute to diagnosing or treating the disease. Rather, they are a combination of some CT features and laboratory data which might better help us to decide whether a certain patient is suspected of COVID-19 or H1N1 pneumonia. The factors that persuade us to consider the patients as COVID-19 include the presence of peripheral and multiple GGO, presence of subpleural sparing and subpleural band, absence of pleural effusion, and lower lobe consolidations. Other findings in CT images such as crazy paving sign and bronchiectasis were found in Zhilan et al. (28) to be significantly different in the 2 groups. In this study, contrarily these 2 features, besides Atoll sign (reversed halo sign- central ground glass opacity surrounded by denser consolidation of crescentic shape- forming more than three-fourth a circle or complete ring of at least 2 mm in thickness all presented in high resolution CT) (29), air trapping, and air bronchogram, had no significant difference regarding their distribution patterns.

TABLE 4. Comparison of 3 Radiologist's Diagnosis Pairwise

	COVID-19	H1N1	Total	% of agreement	Measure of Agreement (kappa)	p value
Radiologist 1	Radiologist 2					
	COVID-19	36 (47%)	18 (23%)	54 (70%)	72%	0.419
	H1N1	4 (5%)	19 (25%)	23 (30%)		
Total	40 (52%)	37 (48%)	77 (100%)			
Radiologist 1	Radiologist 3					
	COVID-19	43 (51%)	12 (14%)	55 (65%)	80%	0.584
	H1N1	5 (6%)	25 (29%)	30 (35%)		
Total	48 (57%)	37 (43%)	85 (100%)			
Radiologist 2	Radiologist 3					
	COVID-19	36 (46%)	4 (5%)	40 (51%)	79%	0.587
	H1N1	12 (16%)	26 (33%)	38 (49%)		
Total	48 (62%)	30 (38%)	78 (100%)			

Despite some differences in CT findings of the 2 groups, the CT score that determines the final outcome of this diagnostic modality was not significantly different. However, this difference was shown to be significant in a recent study on patients with COVID-19 and H1N1 pneumonia (6 versus 15, respectively) (28). This discrepancy is thought to be the result of our small sample size for the 2 groups.

In the present study, we compared 3 radiologists' diagnostic impressions on patients' CT scans with the aim of obtaining a unique concept that would provide a standard reporting language, thereby making a more accurate and relevant diagnosis in patients suspected of COVID-19. By means of interobserver agreement between radiologists in the present study, we will be more able to connect to physicians who provide the same approach and diagnosis. The current results showed that there is a relatively good agreement between expert chest radiologists about the report of CT scans among suspected COVID-19 patients. In the present study, of all 84 cases examined by radiologists, the agreement rate (measure of agreement -kappa) between the 3 radiologists was 65.8%. The degree of agreement about the diagnoses of either radiologist was significant for a pairwise condition. Overall, due to the infectious nature of influenza and COVID-19 diseases and their similarities of lung involvement in both diseases, a definite diagnosis on suspected patients is very hard. Therefore, chest radiologists need some unique clues to distinguish and impute net diagnosis on viral pneumonia patients as well. As a critical issue worldwide, early diagnosis, isolation, and on-time treatment for patients infected by COVID-19 viral pneumonia is highly vital and need a standard agreement between radiologists globally (30). Debray et al. investigated the observer agreement between 8 physicians out of 2 junior radiologists, 2 thoracic, and 2 general senior radiologists and 2 emergency physicians. They found a good Kappa coefficient between all readers (31). Also, in another study by Byrne et al. (32), they used the Radiological Society of North America (RSNA) expert consensus guidelines to assess the interobserver variability and agreement between chest radiologists diagnosing suspected COVID-19 pneumonia patients. They showed a good interobserver agreement among expert chest radiologists ruling in suspected patients, especially in case of false-negative RT-PCR tests.

Regarding impact of COVID-19 pandemic on all varieties of patients globally, diagnose, and isolate viral respiratory infections such as H1N1 influenza have not been convenient. Indeed, performing high resolution chest CT scan for all patients according to their conditions was difficult. Besides these strengths, our study had some limitations due to the small sample size and low number of radiologists included for reporting CT scans. Moreover, we did not use the Radiological Society of North America (RSNA) expert consensus guidelines to compare reports by the radiologists. Furthermore, CT findings could not be related with the severity of symptoms, the onset of disease, and the final prognosis due to lack of available clinical data. On the other hand, we did not evaluate chance of co-infection in our study individual that

could be biased our results. In our study COVID-19 patients received more doses of antiviral drugs than patients with H1N1 influenza that should be affect resolving lung involvements in such patients; so, for future studies we recommend much more group equalization to reach the more reliable findings.

CONCLUSION

The present study showed some significant differences between the thin-cut CT scan features of patients infected with COVID-19 and influenza A virus. A number of common features such as GGO, subpleural sparing and subpleural band were found to be more prevalent in COVID-19 patients, while pleural effusion and consolidation had higher prevalence in individuals with H1N1 influenza. Not only were the peripheral zones of lung more affected in COVID-19 patients, but also the pattern of lung involvement was in the order of multiple lesions in these patients. Meanwhile, H1N1 influenza showed a great inclination to injure lower-lobe segments of the lungs. With respect to the interobserver agreement, we found a good Kappa coefficient between our chest radiologists and concluded if there is a standardized reporting system for radiologists to diagnose the suspected patients, we will obtain an optimal net diagnosis without any delay during this worldwide pandemic.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interests.

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