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Short communication

Is COVID-19 pneumonia differentiable from other viral pneumonia on CT scan?

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During the first wave of the SARS-CoV-2 pandemic, chest computed tomography (CT) scan has been used as a fast and effective method for the diagnosis of Coronavirus Disease 2019 (COVID-19) pneumonia [1]. The typical CT features of COVID-19 pneumonia have been largely reported and mention bilateral ground-glass opacities predominating in the subpleural, posterior and basal parts of the lungs as main CT findings [2]. Over time, ground-glass opacities tend to transform into crazy paving areas and are progressively replaced by linear consolidation or other patterns of organizing pneumonia [2–4]. Regarding CT diagnostic performance for COVID-19 pneumonia, a metaanalysis including 31 studies reported a pooled sensitivity of chest CT in suspected COVID-19 participants of 89.9% and a pooled specificity of only 61.1% [5]. False positives usually result from other pulmonary infections, pulmonary edema or fibrotic interstitial lung diseases, which also include ground glass opacities as predominant CT feature. Apart from COVID-19, CT characteristics of other viral pneumonias are more diverse, especially depending on the immune status of the host [6], but they have been less extensively described since CT is not largely performed in immunocompetent patients. The purpose of our study was to assess

the performance of French radiologists in differentiating COVID-19 from other viral pneumonia by chest CT.

Using our computed hospital information system, we retrospectively included patients referred for unenhanced chest CT scan in a context of lower respiratory tract symptoms who had:

- a RT-PCR-confirmed diagnosis of non-COVID-19 viral pneumonia from December to March 2018 ($n = 28$) or;
- a RT-PCR-confirmed diagnosis of COVID-19 in the first two weeks of March 2020 ($n = 41$).

During these periods, patient selection was consecutive and no exclusion criteria were applied. For the non-COVID patients, among the panel of viruses which were screened, the predominant viruses were influenza A, RSV and picornavirus whereas the other identified viruses were influenza B, metapneumoviruses, parainfluenza viruses and coronaviruses OC43 and 229E.

A radiologist not involved in the CT readings downloaded the CT images from the hospital picture archiving and communications system and removed all identifying information as well as the acquisition date. Five radiologists (with 20, 8, 7, 2 and 1 year of experience in thoracic imaging) independently reviewed the fully anonymized CT images blinded to the laboratory results and date of the CT examination. For each of the 69 patients, ten CT features were analyzed, as well as the distribution and the extent of the pneumonia (Table 1). Lastly, each radiologist had to determine whether the

Abbreviations: COVID-19, Coronavirus Disease 2019; RT-PCR, Reverse Transcriptase Polymerase Chain Reaction; CT, Computed Tomography; GGO, Ground-Glass Opacities.

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Table 1
CT findings and univariate analysis.

CT findings	All n = 69	COVID-19 n = 41	Other viral pneumonia n = 28	Odds Ratio for COVID-19	P-value
Subpleural bands of ground-glass opacities	38 (55%)	37 (90%)	1 (4%)	208.9 [24.3; 910.7]	< 0.001
Ground-glass opacities in central areas	32 (46%)	28 (61%)	4 (14%)	12.4 [3.3; 59.4]	< 0.001
Crazy paving	16 (23%)	16 (39%)	0 (0%)	inf [3.7; inf]	< 0.001
Non-linear consolidation	34 (49%)	17 (41%)	17 (61%)	0.5 [0.2; 1.4]	0.145
Linear consolidations	36 (52%)	27 (66%)	9 (32%)	3.4 [1.3; 12.9]	0.008
Architectural distortion	7 (10%)	4 (10%)	3 (11%)	0.9 [0.1; 6.7]	1
Microvascular dilation sign	1 (1%)	1 (2%)	0 (0%)	inf [0.0; inf]	1
Micronodules	14 (20%)	0 (0%)	14 (50%)	0 [0; 0.1]	< 0.001
Thickening of the bronchial walls	24 (35%)	2 (5%)	22 (79%)	0.0 [0; 0.1]	< 0.001
Pleural effusion	10 (14%)	4 (10%)	6 (21%)	0.4 [0.1; 1.9]	0.296
Thoracic lymphadenopathy	12 (17%)	5 (12%)	7 (25%)	0.4 [0.1; 1.8]	0.205
Peripheral predominance	35 (51%)	33 (80%)	2 (7%)	49.1 [9.4; 509.6]	< 0.001
Posterior predominance	28 (41%)	26 (63%)	2 (7%)	21.5 [4.4; 211.3]	< 0.001
Superior predominance	7 (10%)	5 (12%)	2 (7%)	1.8 [0.3; 20.2]	0.625
Inferior predominance	24 (35%)	21 (51%)	3 (11%)	8.5 [2.1; 50.7]	< 0.001
Disease extent					< 0.001
0%	3 (4%)	0 (0%)	3 (11%)		
< 10%	32 (46%)	8 (20%)	24 (86%)		
10–25%	22 (32%)	21 (51%)	1 (4%)		
25–50%	11 (16%)	11 (27%)	0 (0%)		
50–75%	1 (1%)	1 (2%)	0 (0%)		
> 75%	0 (0%)	0 (0%)	0 (0%)		

chest CT scan was suggestive of COVID-19 pneumonia or other viral pneumonia.

A generalized linear model was used to identify the association between each CT feature and the diagnosis of COVID-19 or other viral pneumonia. In case of discordance between the 5 radiologists for the presence of a CT feature, it was considered to be present if found by at least 3 of the readers.

The CT features that were the most strongly associated with COVID-19 pneumonia were bands of subpleural ground-glass opacities (odds ratio (OR) [95% confidence interval (95%CI)] = 208.9 [24.3; 910.7]), $P < 0.001$, ground-glass opacities in central areas (OR = 12.4, 95% [3.3; 59.4]), $P < 0.001$ and crazy paving (OR = inf, 95% [3.7; inf]), $P < 0.001$ (Table 1). Conversely, thickening of the bronchial walls and micronodules were more frequently associated with non-COVID-19 pneumonia (OR = 0.0 [0; 0.1]), $P < 0.001$. No significant association was found for other CT features such as architectural distortion, pleural effusion and thoracic lymphadenopathy. Regarding the distribution of the pneumonia, peripheral (49.1 [9.4; 509.6], $P < 0.001$), inferior (8.5 [2.1; 50.7], $P < 0.001$) and posterior predominance (21.5 [4.4; 211.3], $P < 0.001$) were significantly associated with COVID-19 pneumonia. Another important finding is that pneumonia extent was very limited, below 10% for almost all (97%) non-COVID viral pneumonias, compared to only 20% limited extent for COVID-19 pneumonias.

The five radiologists had an averaged sensitivity of 96.7% (range = 91.1 to 100%) for COVID-19 pneumonia diagnosis whereas all had 100% specificity. The averaged accuracy was 98% (range = 94 to 100%). The sensitivity and specificity of CT reading by French radiologists to differentiate between COVID-19 and other viral pneumonia in our study were higher than that previously reported for radiologists from the United States and China, who had a sensitivity of 70% and a specificity of 84% [7]. This might be due to the availability from March 2020 of a structured report for COVID-19 pneumonia on the website of the French Society of Radiology, highlighting CT features in favor and against the diagnosis of COVID-19 [8].

Our study has several limitations. First, in view of the rarity of symptomatic viral pneumonias requiring chest CT in immunocompetent patients, it was not possible to collect a large number of CT scans in the two categories, COVID-19 and non-COVID-19 pneumonia. However, the readers were unaware of their respective proportion. CT exams were performed at different study times, but this is unlikely to influence the readings as the date of CT acquisition was not visible and the acquisition protocols during these two times were similar. Lastly, due to the small size of the study population it was not possible to conduct multivariate analysis. In conclusion, CT features of COVID-19 are different from those of other viral pneumonias, with more important pneumonia extent, subpleural bands of ground glass opacities and crazy paving being highly suggestive of COVID-19 pneumonia.

Disclosure of interest

The authors declare that they have no competing interest.

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