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Contribution of Computed Tomography in the Diagnosis of Pulmonary Lesions Due to Coronavirus Disease (SRAS-CoV-2), COVID-19

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Abstract

Our study was carried out at Robert BALLANGER Hospital, its aim was to determine the contribution of the scanner in the diagnosis of COVID-19. It was a prospective descriptive study during the first wave of the COVID-19 epidemic in France. Patients were referred to the medical imaging department for a thoracic CT scan without contrast injection or an angioscanner in the context of a suspected COVID-19 pneumopathy or pulmonary embolism. The study involved both sexes, the male sex was with 55.20% and sex ratio of 1.24. In our study 50% of our patients had a comorbid factor, of which diabetes and hypertension were the most represented with 33% and 17%. The RT PRC test is considered the gold standard in the diagnosis of COVID-19 disease. This test was positive in 63.62% of our patients. CT imaging played a key role in the management of COVID-19 pneumonia because chest CT scans found lesions consistent with COVID-19 pneumonia in 71% of patients. The depoliated lung lesion was present in 87% of our patients, with sub

pleural topography and minimal parenchymal involvement predominating. In our study, the chest CT scan had a higher sensitivity and a lower specificity than the PCR test.

Keywords

Contribution, CT, COVID-19, SARS-CoV-2, Diagnosis, Lungs, France

1. Introduction

Coronavirus belongs to the family of coronaviridae which can cause various clinical manifestations such as pneumonia, fever, respiratory difficulty, up to acute respiratory distress syndrome (ARDS) [1]. These viruses are known in animals worldwide, but very few cases have been known to affect humans. The World Health Organization (WHO) used the term COVID-2019 to refer to the new coronavirus that affected the lower respiratory tract of patients with pneumonia in Wuhan, China, on December 29, 2019 [2]. WHO announced that the official name for the new 2019 coronavirus is coronavirus disease (COVID-19) [3]. The current reference name for the virus is coronavirus.

According to current diagnostic criteria, identification of the viral pathogen via nucleic acid detection (usually from a swab test) is considered the gold standard and formative assessment for the diagnosis of COVID-19 [4].

Imaging examination has become the indispensable means not only for early detection and diagnosis, but also for monitoring the clinical course, assessing the severity of the disease and can be presented as an important warning signal preceding negative Reserve transcriptase polymerase chain reaction (RT-PCR) test results [5]. Computed tomography (CT) imaging is highly recommended as it is very sensitive in detecting early disease, assessing the nature and extent of lesions, and discovering subtle changes that are often not visible on chest radiography. The imaging characteristics of the lesions are always described with the following factors: distribution, quantity, shape, pattern, density, and concomitant signs [6]. In our institution there has been no previous study on the CT aspects of COVID-19 disease. We initiated it to compare the abnormalities found with those in the literature in order to improve the strategy and management of patients.

Purpose: To study the peculiarities of CT aspects of pulmonary lesions of coronavirus (SARS-CoV-2).

2. Material and Method

The study was conducted in the medical imaging department of the Robert Ballanger intercommunal hospital in Aulnay-sous-Bois, France.

The department is located in building 25 on the first floor and has two 64-bar scanners, a 3-Tesla MRI, three ultrasound machines, three digital X-ray tables and a mammography machine.

The staff is made up of radiologists called hospital practitioners, associated trainees, national interns, foreign interns (FFI), manipulators, secretaries and stretcher bearers.

The hospital is located in the department 93 in Ile de France, on the general street Robert Ballanger, in front of the shopping center and the station of Sevran Beaudottes.

This was a cross-sectional, descriptive study with prospective data collection during the first wave of the coronavirus (SARS-CoV-2) epidemic (March 2020 to May 2020).

The study involved any patient who had received a thoracic CT scan or thoracic angioscan in the medical imaging department during the first wave of the coronavirus (SARS-CoV-2) epidemic (March 2020 to May).

Any patient admitted to the medical imaging department for suspected coronavirus (SARS-CoV-2) or suspected pulmonary embolism associated with coronavirus and who has had a chest CT scan or a chest angioscan.

Excluded from our study are all patients who have undergone a thoracic CT scan or a thoracic angioscanner in the medical imaging department, for suspicion of coronavirus (SARS-CoV-2), or a suspicion of pulmonary embolism associated with coronavirus (SARS-CoV-2), but who do not present lesions or abnormalities suggestive of these pathologies.

The sample consisted of patients who underwent a thoracic CT scan or thoracic angioscan in the context of suspected coronavirus (SARS-CoV-2), covid-19 or suspected pulmonary embolism associated with coronavirus (SARS-CoV-2), from computerized patient records, reports and images computerized in the picture archiving and communication system (PACS).

Studied variables:

- **Socio-demographic parameters**: age, gender, occupation, residence, risk factors, history of hypertension, diabetes or known lung disease.
- **Clinical parameters**

– Pulmonary signs (cough, dyspnea, desaturation, chest pain).
– Otorhinolaryngology (ENT) signs: anosmia, agueusia.
– General signs: fever, asthenia.
– **Biological parameters**: PCR, NFS, CRP and D Dimers.
– **CT parameters:**

CT signs (sub pleural frosted areas/condensations, condensed bands, thickening of the septa, crazy paving, percentage of parenchyma affected).

Signs on thoracic angioscan, associating pulmonary embolism and Coronavirus (SARS-CoV-2).

The information was collected anonymously. The dissemination of the results of this study will be done in strict compliance with medical and research ethics.

The techniques studied were thoracic CT, with millimetric helical acquisition without injection of iodinated contrast medium.

Thoracic angioscan in millimetric helical acquisition with injection of iodinated contrast medium at the pulmonary arterial time.

The diagnostic criteria for coronavirus (SARS-CoV-2), COVID-19 on CT scan according to the French Society of Radiology/French Society of Thoracic Imaging are:

- Frosted glass areas (parenchymal overdensity that does not obscure vessel and bronchial contours) under the pleura/condensation.
- Condensation strips.
- Thickening of the septa.

Crazy paving appearance: this appearance presents as a ground glass area with septal thickening and cross-linking.

Data analysis (socio-demographic, clinical, biological and radiological) was done using SPSS version 22.0 software. The threshold of 5% was decided of the significance of the analyzed variables. The sensitivity of chest CT was calculated using the relationship, Sensitivity = VP/(VP + FN), VP: true positive CT: patients with positive CT with positive RT PCR test and FN: false negative CT: patients with negative CT and with positive RT PCR test.

3. Results

During our study 1408 thoracic scans were performed, distributed as follows. Chest CT without injection represented 82.9% and chest angioscan 17.1% of the department's chest CT activities during the first wave of the epidemic in France.

Patients in the age group 61 - 80 years were the most affected with 39.53% of the population. Men were the most affected with a sex ratio of 1.24.

In our study, 50% of our patients had a comorbidity factor, of which diabetes and hypertension were the most represented with 33% and 17%. 71.6% of our patients were referred to us by the emergency room—"COVD Unit". Clinical suspicion of COVID-19 pneumopathy dominated by cough was the reason for CT scan in 72% of our patients.

We found that 63.62% of the population was PCR positive on nasal or oropharyngeal swabs.

In our sample, 71% of patients had CT lesions suggestive of COVID-19 pneumonia. Pure ground glass lesions were the most frequent lung lesions with 87%, followed by septal thickening (22%), pulmonary condensation (16%) and crazy pavement lesions (8%) (**Table 1**). Among our patients, minimal lung parenchymal involvement was found in 40.60% of our patients, 24.4% moderate involvement and 25.5% extensive lung injury. Severe and critical involvement represented 6.69% and 3% respectively (**Figure 1**). These lesions evolved without complications in 81% of the cases under treatment at the follow-up scan (**Figure 2**). During the evolution of the COVID-19 pneumopathy lesions, we had signs of complication in only 10% of the cases composed of pneumothorax, pleurisy and pulmonary abscess (**Figure 2**). Subpleural topography (**Figure 3** arrow) was the most represented with 42% as location. Central lesion topography was noted in only 18% of our patients. In the remaining cases, the topography was mixed.

Table 1. Distribution of patients according to the type of pulmonary lesion found.

Type of lung lesions	Present	Absence
Pure frosted glass	87%	13%
Septal thickening	22%	78%
Condensation	16%	84%
Crazy paving (**Figure 5**)	8%	92%

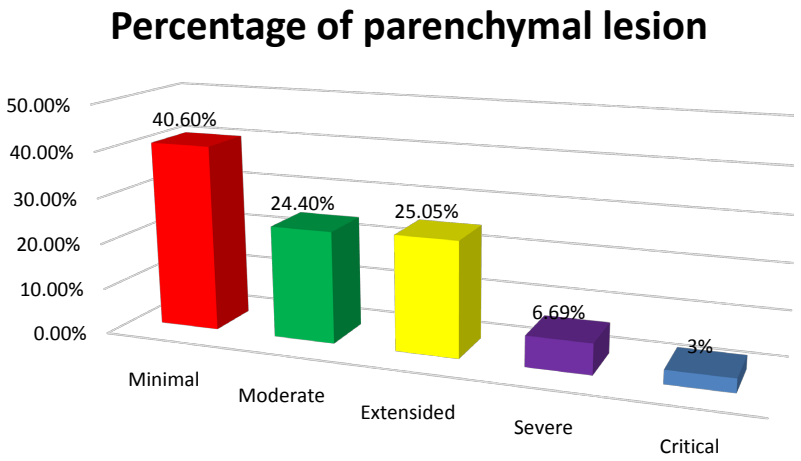

Figure 1. Distribution of patients according to the percentage of lung parenchyma affected. Minime = Minimal; Modéré = Moderate; Etendu = Extended; Sévère = Severe; Critique = Critical.

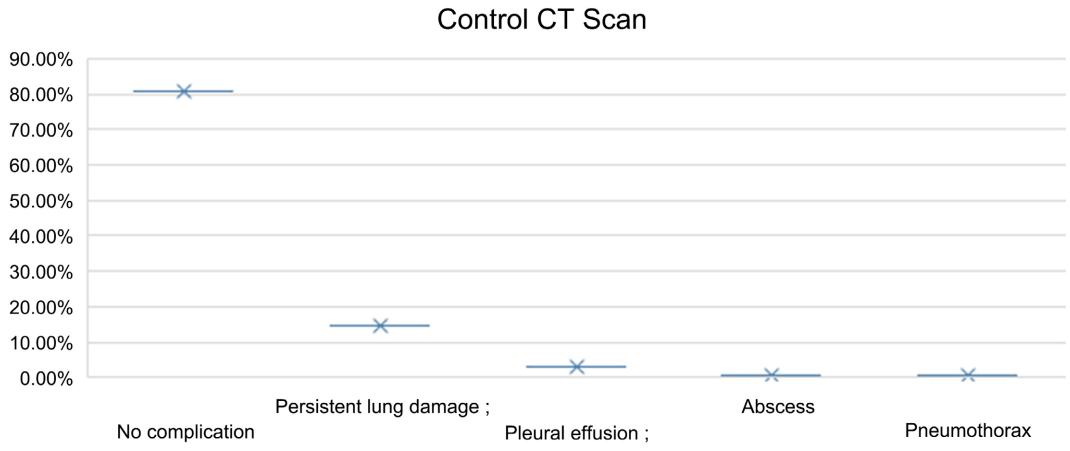

Figure 2. Distribution of patients according to the evolution of lesions of COVID-19 pneumopathy.

Pulmonary embolism was found in 6.80% of our patients among those who had a thoracic angioscan.

In our study, CT was more sensitive than PCR (0.34 > 0.30) (**Table 2**).

The evolution of COVID-19 related lung lesions after one month, ground glass and septal thickening lung lesions were found in 14.40% of our patients on the follow-up CT scan (**Figure 4**). The ground glass lesions with crazy paving (**Figure 5**) evolved slowly compared to the pure ground glass lesion. At 6

Table 2. Sensitivity and specificity of CT and PCR in the diagnosis of COVID-19.

		PCR		Total
		Positive	Négative	
Thoracic CT	Positive	301	698	999
	Negative	595	186	409
Total		896	884	1408

Sp_{TDM} = 0.21 Se_{TDM} = 0.34 VVP_{TDM} = 0.301 VVN_{TMD} = 0.45; Sp_{PCR} = 0.45 Se_{PCR} = 0.301 VVP_{PCR} = 0.33 VVN_{PCR} = 0.36.

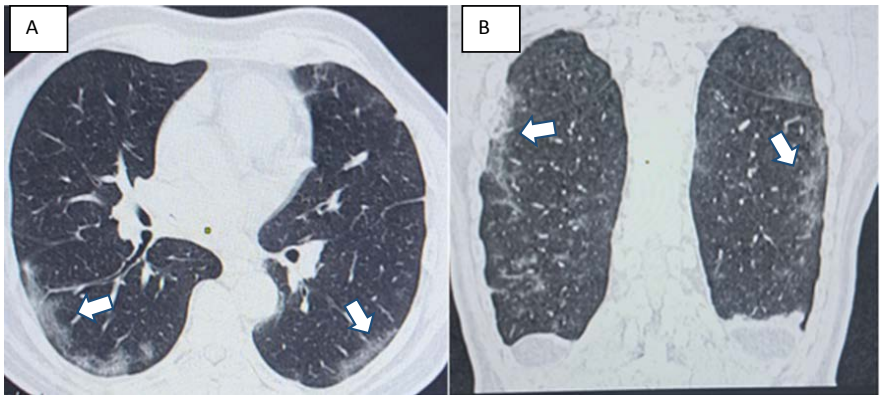

Figure 3. Typical CT presentation of minimal COVID-19 pneumonia in a 38-year-old woman. Chest CT scan without injection in axial (A) and coronal (B) slices showing small bilateral, subpleural ground-glass areas (arrows), predominantly in the posterior regions.

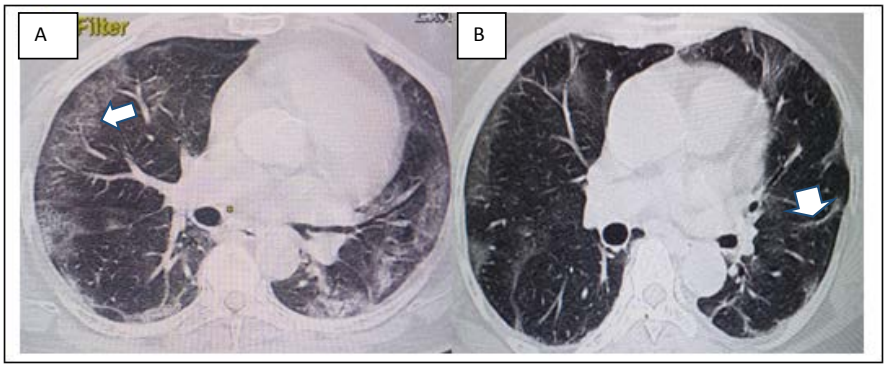

Figure 4. Typical CT presentation of moderate COVID-19 pneumonia in a 57-year-old man. Axial slice injection-free chest CT scan (A) showing bilateral sub pleural ground-glass areas (arrows), predominantly in the posterior regions. Regression of the ground-glass areas on the follow-up CT scan on day 7 (B) of treatment.

months of the controls 12% of the patients had pulmonary sequelae such as scar fibrosis. We found that patients with severe and critical disease had significantly more sequelae (**Figure 6**) than patients with minimal and moderate disease. In our study, 6.17% of our patients died.

In our study TDD is more sensitive than CRP (0.34 > 0.30) while CRP is more specific than CT (0.45 > 0.21).

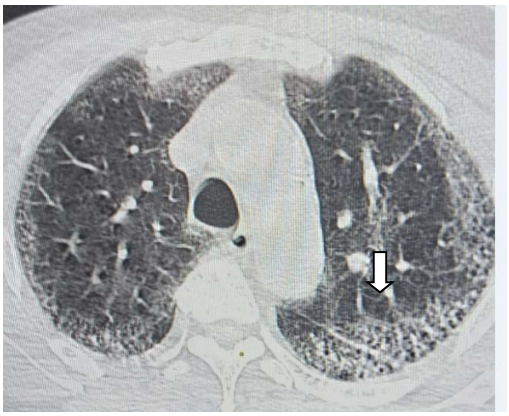

Figure 5. CT presentation of moderate COVID-19 pneumonia in a 28-year-old woman. Chest CT scan without injection in axial slices (A) showing bilateral "CRAZY PAVING" areas, sub pleural.

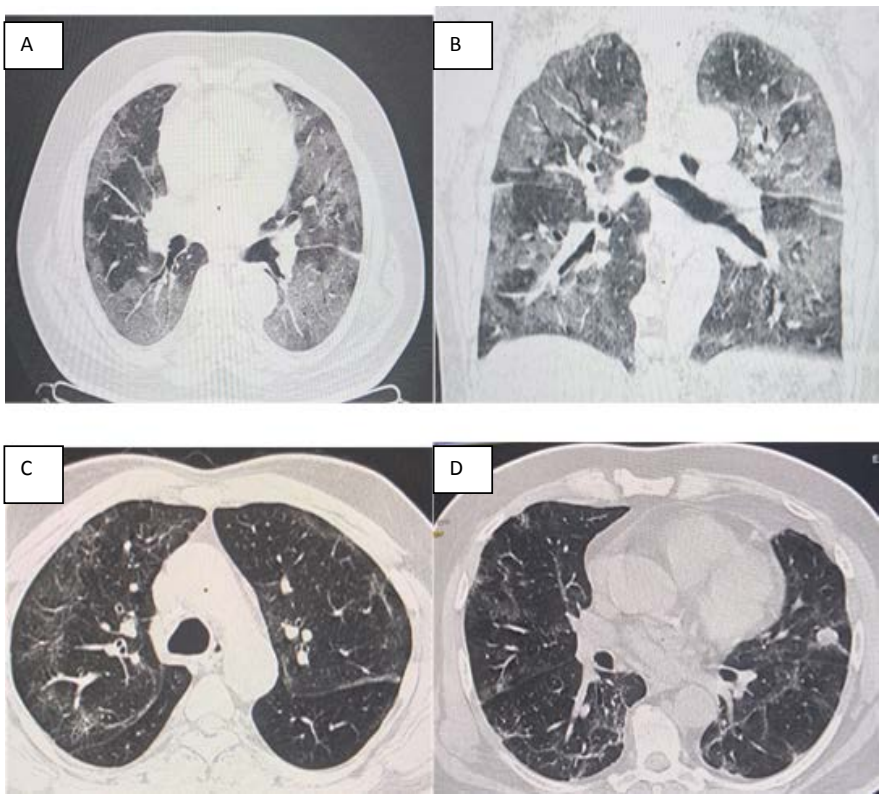

Figure 6. Typical CT presentation of extensive COVID-19 pneumonia in a 63-year-old man. Non-injection chest CT scan in axial (A) and coronal (B) slices showing bilateral, diffuse ground glass areas (arrows). Regression of the ground-glass areas on the follow-up scan at Day 14 (C, D) of treatment.

4. Comments and Discussion

Range of 61 - 80 years were most affected with 39.53% of the total number. The male sex represented 55.20% of the cases with a sex ratio of 1.24 is different from the study of Wu C. *et al.* [7] in Wuhan in China where the male sex represented 63.5% with a sex ratio of 1.8 and the study of Gautret P *et al.* [8] in Marseille in

France where the male sex was 46.4% with sex ratio of 0.86.

Comorbidities such as diabetes and hypertension were present in 33% and 17% respectively. These comorbidities were found in the study of Gautret P *et al.* [9] *et al.* in Marseille in France with 40% and 14% and Zhou F *et al.* [10] with 19% and 30%. The majority of our patients came from the emergency department (SAU) with 71.6% of the total number of our patients, which could be explained by the good organization with the establishment of the "covid" network in this department. 72% of our patients were referred to us for suspected COVID-19.

RT-PCR was positive in 63.62% of our patients, our result is sensibly equal to that of Wang W *et al.* [11] who found 63% of RT-PCR positive this difference could be explained by the fact that the test was not systematic in our study.

The CT scan had found in 71% of our patients pulmonary lesions compatible with COVID-19 pneumopathy. Our figures are higher than those of Million M *et al.* [12] who found 65.7% CT compatible with COVID-19 pneumopathy.

The type of lung lesion, ground glass (**Figure 6(A)** & **Figure 6(B)**) is by far the most frequent lung lesion with 87% it is lower than that of Ruch Y *et al.* [13] who have in 93% ground glass.

The topography of the pulmonary lesions due to COVID-19 pneumopathy in our series were located in 40% of cases in the sub pleural area (**Figure 3**), this location is consistent with the descriptive semiology of the pathology by the French Society of Radiology (SFR).

The percentage of parenchymal lesions, respectively 40.60% and 24.64% of our patients had minimal and moderate parenchymal involvement (**Figure 1**). Our data are different from that of Gautret P *et al.* [8] in Marseille, France, who found 43% minimal involvement and 20.5% moderate involvement.

Pulmonary lesions such as ground glass (**Figure 6(A)** & **Figure 6(B)**) and septal thickening (**Figure 6(C)** & **Figure 6(D)**) were found in 14.40% of our patients on the follow-up CT scan. Pulmonary embolism was found in 6.80% of our patients. Our figures are lower than those of Conan P *et al.* [14] who found 14% of pulmonary embolism. This difference could be explained by the size of the sample which is larger in our study.

The mortality rate was 6.17%. This excess mortality could be explained by the size of the sample, the incidence of the disease in our department and the socio-economic level of the department. It is lower than the study of Zhou F *et al.* in Wuhan, China [9] who found 28.27%. This difference could be explained by the importance of comorbidity which was 48% in their study.

In our study, the chest CT scan had a higher sensitivity and a lower specificity than the PCR test.

5. Conclusions

Covid-19 pneumonia is a true international public health problem. CT imaging plays a key role in the management of COVID-19 pneumonia.

Our study concluded that 63.62% of patients were PCR positive and 71% had CT lesions suggestive of COVID-19 pneumonia. Pure ground glass lesions were the most common pulmonary lesions with 87%, followed by septal thickening (22%), pulmonary condensation (16%) and crazy pavement lesions (8%).

Subpleural topography was the most represented, with 42% as location. Pulmonary embolism was found in 6.80% of our patients among those who had a thoracic angioscan. In our study, CT was more sensitive than CRP (0.34 > 0.30).

The evolution of the lesions of COVID-19 lung disease after 6 months of the controls 12% of the patients had pulmonary sequelae such as scar fibrosis. Hence the need to follow up patients cured of COVID-19 disease to look for and manage possible sequelae.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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