

# Radiological Examinations in Patients With COVID-19

Giuseppe Scappatura

**O**n January 9, 2020, the World Health Organization announced that Chinese health authorities had reported a coronavirus strain that never before had been identified in humans. The virus, classified as SARS-CoV-2, was associated with an outbreak of pneumonia in the city of Wuhan, in the Hubei Province, on December 31, 2019. On February 11, the World Health Organization named the disease derived from this coronavirus COVID-19.<sup>1,2</sup>

## Protection Measures

COVID-19 is highly infectious and spreads through small droplets and by touching contaminated surfaces and then touching mucus membranes such as the eyes, nose, or mouth.<sup>3</sup> Health care workers, including radiologic technologists, who come into contact with patients who have COVID-19 are at risk for acquiring the disease. To protect themselves and others, all health care workers at the Grand Metropolitan Hospital's COVID Department must wear disposable or sterilizable personal protective equipment including:

- aprons
- gloves
- gowns
- head covers
- masks
- shoe covers

In agreement with strict internal practical guidelines, health care workers who have direct contact with patients who have confirmed COVID-19 diagnoses

also must wear protective goggles or plastic face shields, surgical masks (FFP2/3 or N95/99), and coveralls or protective gowns. In concert with wearing personal protective equipment, workers in the COVID Department must sanitize the equipment after every examination using the supplier-recommended disinfectant. For radiologic technologists, that means sanitizing the image receptor, the gantry, the mouse, and the keyboards. After sanitizing the equipment, the workers must wash their hands, apply hand sanitizer, and don clean gloves. Those who are in direct contact with patients affected by COVID pneumonia also are required to change their FFP3 masks after each 8-hour shift.

## Medical Imaging for Diagnosing COVID-19

Radiologic imaging, and therefore radiographers, has a key role in the diagnostic, management, and follow-up process of COVID-19. Patients who have or who are suspected of having the virus might undergo numerous medical imaging examinations, such as chest radiography and computed tomography (CT), to help monitor their clinical measurements during hospitalization.<sup>3</sup>

### Chest Radiography

Standard chest radiography has low accuracy in identifying the early alteration of COVID-19,<sup>3</sup> but if this examination is conducted, it should be acquired with the patient standing, the chest touching the image

receptor. Patients should be asked to take a deep breath and suspend breathing while the exposure is taken. The area of interest for these scans is the center of the lower inner edges of the scapulae, at a focal film distance of 1.80 m (70.9 in). The tube voltage is set to 110 kVp to 125 kVp, and automatic exposure control is used. If an indirect digital radiology system is used, the image receptor should be positioned horizontally or on the long-side of the patient based on body type, and the parts of the patient's body outside the area of interest should be shielded.

### **Bedside Chest Radiography**

For patients who are in critical condition and cannot be moved as readily, bedside chest radiography is used. When performing this type of examination, radiologic technologists must call on every bit of their expertise, skills, and ability to implement accurately various techniques that will ensure a successful examination. While positioning critical patients for a mobile radiography examination, technologists should keep in mind the location of any catheters, lines, and medical devices and be aware of patients' needs and comfort throughout the process.

The patient should be supine, with the arms alongside the body. During the exposure, the patient should not be rotated on the frontal plane; even a minimal rotation of 5° to 10° can result in morphological variations that can affect the projection of the vascular peduncle and the cardiac image. The x-ray beam should be centered between the suprasternal notch and the xiphoid process. The source-to-image distance should be 1.20 m to 1.30 m (47-51 inches) to avoid magnifying and distorting the anatomic structures. The image receptor must be positioned on the shoulder line at the supra apical area of the hemithorax, immediately below the superior edge of the image receptor. If the patient has a confirmed COVID-19 diagnosis, for infection control purposes, the image receptor should be inserted into multiple plastic bags before it is placed between the patient's back and the mattress. The image receptor, thorax, and x-ray tube must be perfectly aligned. The exposure must be short and synchronized with the breath hold and the exposure during inspiration, especially with patients who have poor compliance.

Digital radiography and postprocessing provide sufficient spatial resolution that enables evaluation of possible pulmonary alterations. During advanced stages of the infection, chest radiographs show multifocal bilateral alveolar opacities that eventually will merge and cause lung opacification and possible pleural effusion.<sup>3</sup>

### **Computed Tomography**

Two radiographs on perpendicular planes (ie, coronal and sagittal) are required to plan a volume study, from the lung apices to the diaphragm dome, including bilateral phrenicocostal sinuses. The most common findings on CT scans are multifocal ground-glass areas, patchy areas of consolidation, and a peripheral and subpleural distribution in the posterior regions and lower lobes.<sup>4</sup>

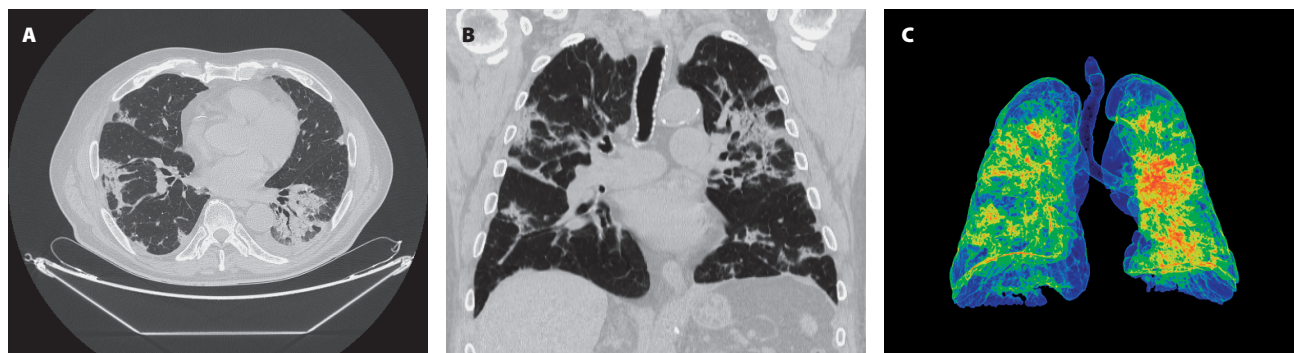
Before a CT chest scan is performed, the stretcher should be covered completely with a disposable sheet, with any wrinkles smoothed out. Patients must wear a mask during transport to and from the imaging suite and throughout the examination. The patient should be arranged in a standard supine position, with the body at the center of the device bed and the arms elevated over the head or, in case of motor difficulties, placed alongside the body.

The chest examination must be carried out during breath hold; if critical-condition patients are unable to hold their breath, the direction of the craniocaudal scan can be switched from the diaphragm dome to the lung apices to reduce artifacts caused by breathing movement, which is more pronounced in the lower part of the lungs than in the apices. Using the low-dose protocol requires an automatic modulation scan based on the patient's body habitus.<sup>5</sup>

If the imaging equipment has no iterative reconstruction capabilities, the manual exposure control should be used, with the x-ray tube set at 100 kVp to 120 kVp, 50 mA to 350 mA, with automatic current modulation. With fixed tube current, the settings should be 50 mA to 100 mA, and step voltage should be 0.5 to 0.8. Correct rendering can be obtained by using a 1.25-mm layer with a high-spatial-frequency reconstruction algorithm (eg, lung and bone), a correct window of image visualization (W/W 1500-600 HU), and a 512 × 512 matrix size (see **Figure 1**).

## Short Report

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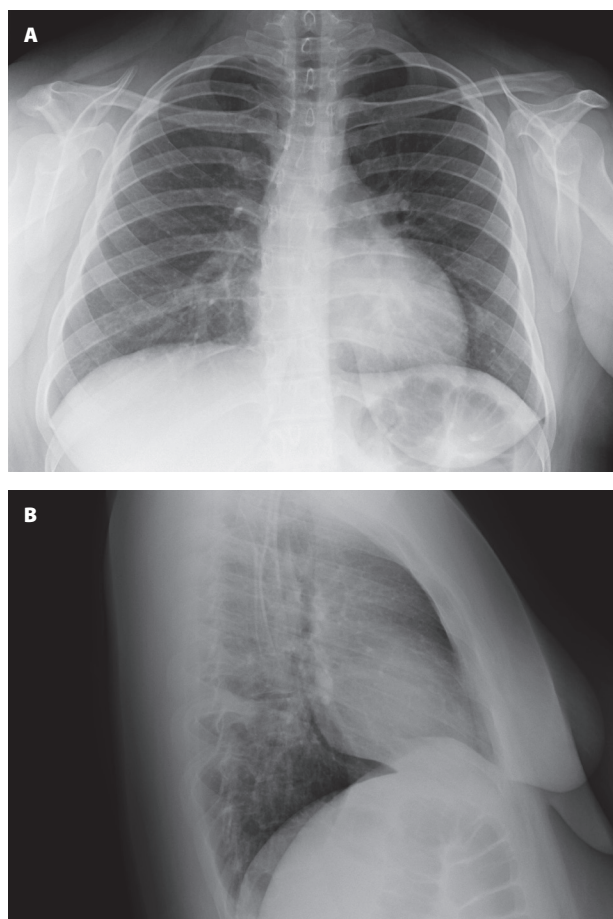


**Figure 1.** Computed tomography (CT) images showing manifestations of COVID-19, including ground-glass opacities and consolidations (A); a multiplanar reconstruction coronal image (B); and 3-D volume rendering consolidations with ground-glass opacities (C). Images courtesy of the author.

### Case Summary: Suspected COVID-19 in a Young Woman

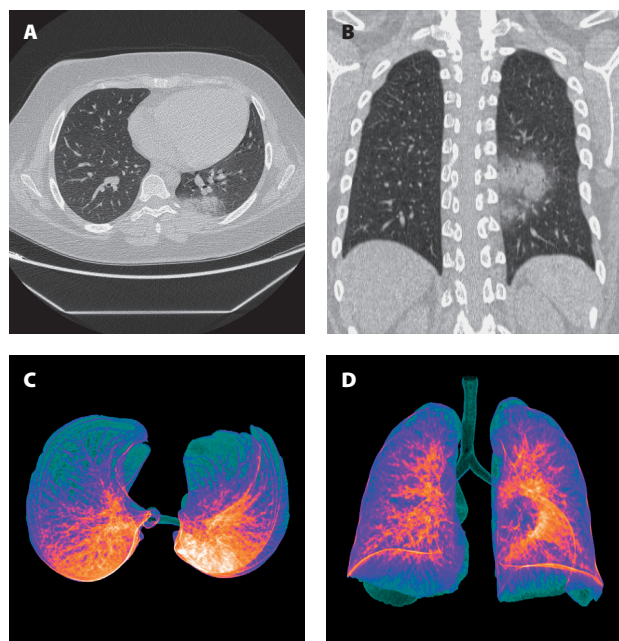
A 20-year-old woman presented to the dedicated COVID-19 Emergency Department at Grand Metropolitan Hospital with symptoms of COVID-19, including fever, cough, and dyspnea. A chest radiography examination in 2 projections was performed, revealing diffuse pulmonary interstitial thickening (see **Figure 2**). After a positive COVID-19 diagnosis was confirmed through a swab test, a CT chest scan was obtained, using the GE Optima CT660 without iterative reconstruction. A subpleural distributed parenchymal consolidation was present in the dorsal apical region of the left lower lobe and extended caudally to the posterior basal segment, with air bronchogram (see **Figure 3**).

The diagnostic reference levels were between 370 to 570 as dose length product and 11 to 13 CT dose index vol (mGy), exposing the patient to an effective dose of 5.18 mSv to 7.98 mSv. The procedure on the patient consisted of low-dose protocol with 100 kV and 50 mA exposure control. It provided interesting results with good image quality without excessive noise. The final ratio of 86.60 dose length product and 2.43 CT dose index vol (mGy) (see **Figure 4**) corresponded to an effective dose of 1.21 mSv, which would protect the patient in future examinations related to other possible COVID pneumonia diagnostic procedures. After a month of therapy, the patient presented a significant improvement in her general clinical picture, with laboratory investigations gradually falling within the reference values. Swab testing on the patient for



**Figure 2.** Posteroanterior (A) and lateral (B) chest radiographs demonstrating diffuse thickening of the pulmonary interstitium. Images courtesy of the author.





**Figure 3.** Low-dose CT chest scans acquired in the initial stage of the disease show typical ground-glass opacity at apical-dorsal segment of the left lung (A) and an multiplanar reconstruction coronal image (B). In addition, 3-D volume rendering (postprocessing) images of CT chest scan were acquired in the initial stage of the disease. The apical-dorsal segment of the left lower lobe colorimetric maps demonstrate the presence of a parenchymal consolidation area with subpleural distribution (C, D). Images courtesy of the author.

COVID-19 was negative. When a second CT scan documented the complete resolution of the disease (see **Figure 5**), the patient was discharged.

## Conclusion

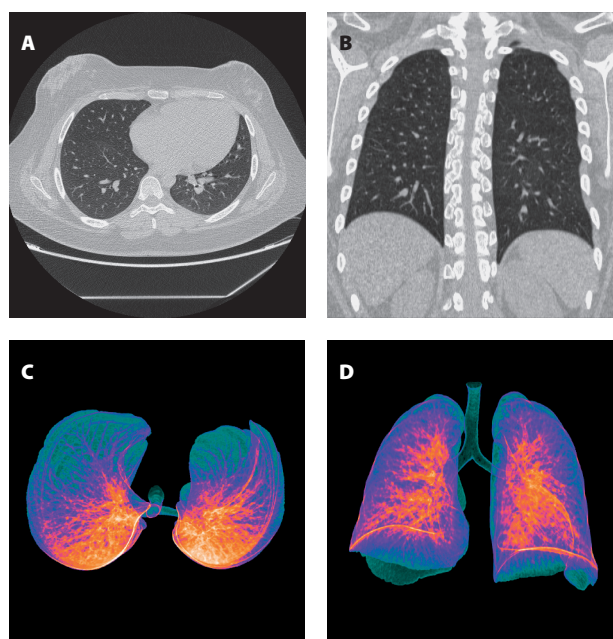
Radiographers have a critical role on the health care team, especially during the COVID-19 pandemic. Not only do they perform the medical imaging chest scans that are crucial to diagnosing the disease and providing necessary follow-up, they also help protect patients' health by adhering to protocol for using the lowest dose possible when obtaining these critical images.

Giuseppe Scappatura is a radiology technician for the UOC of Radiology of the Grand Metropolitan Hospital in Reggio Calabria, Italy. He has qualifications

Exam Description: TAC TORACE AD ALTA RIS

Report Dose					
Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	S22.000-I270.500	2.43	86.60	Body 32
Total Exam DLP:				86.60	
1/1					

**Figure 4.** Report dose. Image courtesy of the author.



**Figure 5.** Re-evaluation of CT scans with axial and coronal acquisition demonstrating a full recovery of the patient (A, B). No additional features of interstitial pneumonia were observed on CT images. The 3-D volume rendering (postprocessing) images also demonstrate full recovery of the patient (C, D). These reconstructions show a colorimetric pattern of the target lesion not notably different from the background. All scans were acquired in the healing stage of the disease. Images courtesy of the author.

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*Hospital, for reviewing the manuscript and optimizing the clinical description of the case.*

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