Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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COVID-19 - A Brief Review of Radiology Testing

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COVID-19 Radiology Testing

Introduction

As discussed in the SARS and MERS sections of this article, early radiographic studies with regular follow up evaluations, including CT scans is important in helping to characterize and quantify the magnitude of illness, as well as monitor progression, which can be rapid in the highly pathogenic coronaviruses, especially COVID-19, as experience worldwide will attest.[1-4]

In the earlier stages of COVID-19, as with other highly pathogenic coronaviruses that cause a severe acute respiratory syndrome, chest XRays often reveal various stages of pneumonia.[1-7] In advancing disease clinical features consistent with acute respiratory distress syndrome (ARDS), and acute cardiac injury may be present.[1, 3-5] Such patients should rapidly receive a CT scan of the chest, which often reveals various forms of ground glass opacity (GGO). In some cases there are multiple GGO located in sub-pleural regions of bilateral lungs. These likely influence the immune response, which may lead to significant pulmonary inflammation.[1-7]

In early work of Hosseiny et al., the diagnosis of COVID-19 is suspected on the basis of symptoms of pneumonia (e.g., dry cough, fatigue, myalgia, fever, and dyspnea) as well as history of recent travel or exposure to a diagnosed positive COVID-19 patient.[1] [See CDC Testing Section on Case Definition and Diagnosis].

Chest imaging plays an important role in both assessment of disease extent and follow-up. Chest radiography typically shows patchy or diffuse asymmetric airspace opacities, similar to other causes of coronavirus pneumonias.[8] Consistent with various early reports, Hosseiny note the first report of patients with COVID-19 described having bilateral lung involvement on initial chest CT in 40 of 41 patients, with a consolidative pattern seen in patients in the ICU and a predominantly ground-glass pattern in patients who were not in the ICU.[1,6]

The highly pathogenic coronaviruses SARS, MERS, and COVID-19 share several clinical and radiographic similarities (Table 1) (Figs. 1 and 2), with some notable exceptions.[1-3,7] The propensity for COVID-19 to involve both lungs more often and earlier in the illness is increasingly well documented.[1] Of note, aggressive testing – radiographic and other modalities, should be utilized

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Table 1
Comparison of Clinical and Radiologic Features of SARS, MERS, and COVID-19
From Hosseiny, et al (1)

Feature	SARS	MERS	COVID-19
CLINICAL SIGNS OR SYMPTOMS			
Fever or chills	Yes	Yes	Yes
Dyspnea	Yes	Yes	Yes
Malaise	Yes	Yes	Yes
Myalgia	Yes	Yes	Yes
Headache	Yes	Yes	Yes
Cough	Dry	Dry or productive	Dry (productive w/progressive illness)
Diarrhea	Yes	Yes	+/-
Nausea or vomiting	Yes	Yes	Less common
Sore throat	Yes	Uncommon	Less common/but possible
Arthralgia	Yes	Uncommon	Less common/but possible
IMAGING FINDINGS			
Acute phase of illness	**SARS**	**MERS**	**COVID-19**
Initial imaging			
Normal	15–20% of patients	17% of patients	15–20% of patients
Abnormalities			
Common	Peripheral multifocal airspace opacities (GGO, consolidation, or both) on chest XRay and CT scans	Diffuse findings similar to SARS	Diffuse findings similar to SARS and MERS; may be more diffuse early, or more rapidly progressive. B/L lung involvement to be expected
Rare	Pneumothorax	Pneumothorax	Pneumothorax
Not seen	Cavitation, lymphadenopathy	Cavitation, lymphadenopathy	Cavitation, lymphadenopathy
Appearance	Unilateral, focal (50%); Multifocal (40%); diffuse (10%) Bilateral, multifocal	Bilateral, multifocal basal airspace on CXR or CT (80%), isolated unilateral (20%)	Bilateral, multifocal, as well as basal airspace are common findings. Of note, a </=15% may present with normal CXR
Follow-up imaging appearance	Unilateral, focal (25%); Progressive (most common, can be unilateral and multi-focal or bilateral with multi-focal consolidation)	Extensive into upper lobes or perihilar areas, pleural effusion (33%), interlobular septal thickening (26%).	Persistent or progressive pleural airspace opacities
Indications of poor prognosis	Bilateral (like ARDS), four or more lung zones, progressive involvement after 12 d	Greater involvement of the lungs, pleural effusion, pneumothorax	Consolidation vs ground glass opacities (GGO)
	SARS	**MERS**	**COVID-19**
Chronic phase of illness			**Data still being reviewed**
Transient reticular opacities (e)	Yes	Yes	
Air trapping	Common (usually persistent)		
Fibrosis	Rare	One-third of patients	Data still being reviewed

Acronyms: GGO = ground-glass opacity, ARDS = acute respiratory distress syndrome. aOver a period of weeks or months.

early with moderately to severely ill COVID-19 patients owing to significant extrapulmonary illness.[1-4]

Consider in Fig. 1 [9] a CT study obtain from a 27 yo MERS patient. Notice the Lower lung image reveals large right lower lobe and small focal left lower lobe subpleural consolidations. Fig. 2 [1] is from a 79 yo COVID-19 patient. Notice bilateral multiple, patchy, and peripheral ground glass opacities (GGO)

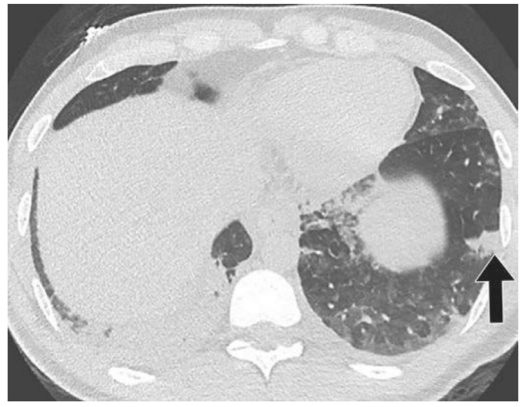

Fig. 1. [9] a CT study obtain from a 27 yo MERS patient. Notice the Lower lung image reveals large right lower lobe and small focal left lower lobe subpleural consolidations.

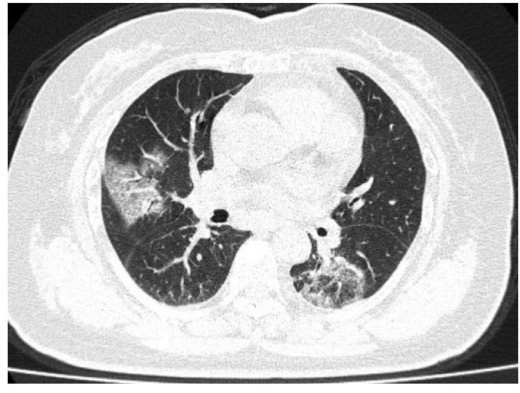

Fig. 2. [1] (Courtesy of Song F, Shanghai Public Health Clinical CenteShanghai, China) From a 79 yo COVID-19 patient. Notice bilateral multiple, patchy, and peripheral ground glass opacities (GGO).

A study reviewing the initial chest CT findings in 21 individuals with confirmed COVID-19 revealed abnormal findings in 86% of patients, with a majority (16/18) showing bilateral lung involvement.[7] Multifocal ground-glass opacities (GGO) (57%) and consolidation (29%) were also reported. Of note there was a tendency towards peripheral lung involvement (Figs. 2 and 3).[1]

In another study, chest imaging was obtained from a family cluster of seven persons with testing confirmed COVID-19; their studies showed bilateral patchy ground-glass opacities. There was greater involvement of the lungs reported among older family members.[1, 10]

As noted earlier, although imaging features of COVID-19 resemble those of MERS and SARS,[1-4] it is important to recognize involvement of *both lungs* on initial imaging is more likely to be seen with COVID-19 (Figs. 3 and 4).[1] By comparison, initial chest imaging abnormalities in SARS and MERS more often are unilateral (Table 1).[1-3]

Figs. 3 and 4 are from a 79 yo female who presented with fever, dry cough, and chest pain for 3 days. Her husband and daughter-in-law had been recently diagnosed with coronavirus disease 2019 (COVID-19). The patient experienced progressive illness, and expired 11 days after admission.[1]

The next CT scans (Figs. 5 and 6) were obtained from a 47 yo man with 2-day history of fever, chills, productive cough, sneezing, and fatigue who presented to the emergency department, and was ultimately diagnosed with COVID-19.[1]

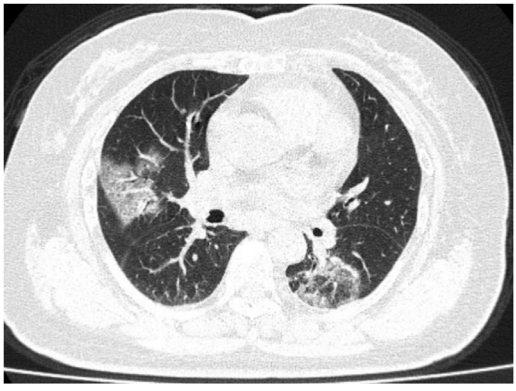

Fig. 3. [1] - 79-year-old woman Axial (**A**) CT Image showing multiple patchy, peripheral, bilateral areas of ground-glass opacity (Courtesy of Song F, Shanghai Public Health Clinical Center, Shanghai, China).

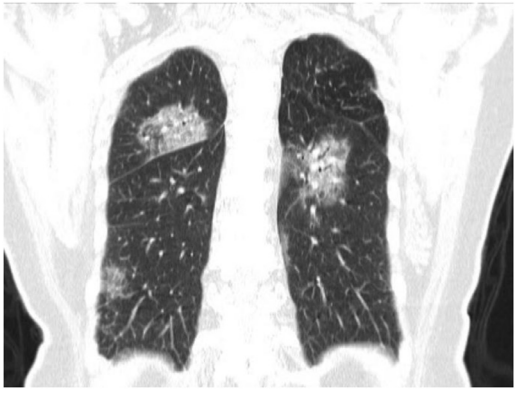

Fig. 4. [1] CT image (Courtesy of Song F, Shanghai Public Health Clinical Center, Shanghai, China) Multiple patchy, peripheral, bilateral areas of ground-glass opacity.

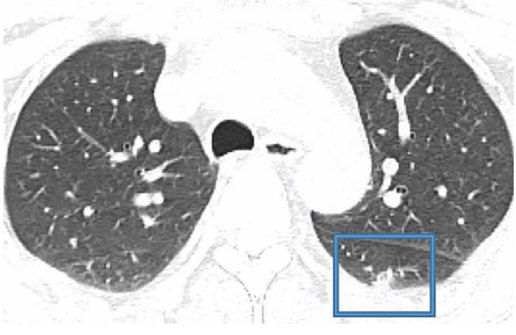

Fig. 5. [1] 47-year-old COVID-19 patient. Initial CT images obtained show small round areas of mixed ground-glass opacity and consolidation (*rectangles*) at level of aortic arch (**A**) and ventricles (**B**) in right and left lower lobe posterior zones. (Courtesy of Liu M, China-Japan Friendship Hospital, Beijing, China).

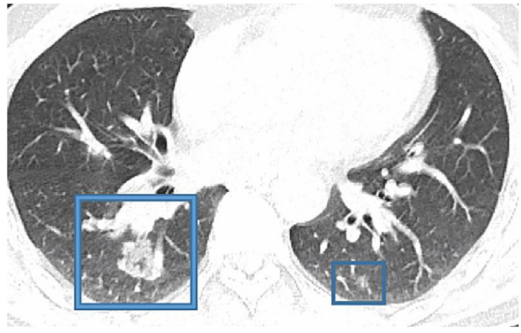

Fig. 6. [1] Initial CT images obtained show small round areas of mixed ground-glass opacity and consolidation (*rectangles*) at level of aortic arch (**A**) and ventricles (**B**) in right and left lower lobe posterior zones. (Courtesy of Liu M, China-Japan Friendship Hospital, Beijing, China).

As noted in the above CT scans, COVID-19 can cause early and significant pulmonary findings on chest CT, which may progress rapidly. The severity of which may portend early or greater extrapulmonary involvement. The astute clinician will anticipate the potential for rapid clinical deterioration, especially in higher risk populations, as described earlier (including advancing age, frailty, immunosuppressed state – from disease or pharmacotherapy, cardiac and other comorbidities) and manage the patient accordingly. It is worth repeating that individuals considered lower risk have also experienced rapid deterioration, and death, such that the use of risk stratification while important in accelerating management, should be used with the caveat we cannot let our guard down for any patient, as COVID-19 demonstrates an ability to cause rapidly progressive illness even among younger and seemingly more robust adult patients.

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