Review article

Imaging findings in the pulmonary progression of patients with COVID-19

DOI: 10.5377/alerta.v9i2.20106

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1. 0009-0008-4449-5048
2. 0009-0006-7602-5732

OPEN ACCESS

Hallazgos imagenológicos en la evolución pulmonar de pacientes con COVID-19

Suggested citation:
Lozano Hernández F, Diaz Portillo N. Imaging findings in the pulmonary progression of patients with COVID-19. Alerta. 2026;9(2):127-133. DOI: 10.5377/alerta.v9i2.20106

Editor:
David Rivera.

Received:
February 17, 2025.

Accepted:
March 3, 2026.

Published:
April 30, 2026.

Author contribution:
FSLH[1]: study conception, manuscript design, literature search, writing, revising and editing. NSDP[2]: data or software management, data analysis.

Conflicts of interest:
No conflicts of interest.

Abstract

The COVID-19 outbreak has had a significant impact on public health, with the greatest impact on older adults and those with comorbidities such as cardiovascular disease, diabetes, and respiratory conditions. Radiological evaluation has been essential for the diagnosis and management of pulmonary complications resulting from the disease. The objective of this article is to describe the imaging techniques and the main radiological findings observed in the pulmonary progression of patients with COVID-19. Chest X-rays, although readily available, have limited sensitivity; in contrast, computed tomography has stood out for its high accuracy, which allows for the identification of lesions such as ground-glass opacities and consolidations. These techniques not only aid in initial diagnosis but also in monitoring disease progression and detecting long-term sequelae. Imaging techniques have proved to be a useful tool for diagnosing and monitoring lung damage in patients with COVID-19, enabling more effective management of the most vulnerable patients and improving long-term prognosis.

Keywords

COVID-19, Radiography, Thoracic, Coronavirus Infections.

Resumen

El brote de COVID-19 ha generado un impacto significativo en la salud pública, con mayor repercusión en las personas de edad avanzada y a aquellas con comorbilidades como enfermedades cardiovasculares, diabetes y patologías respiratorias. La evaluación radiológica ha sido esencial para el diagnóstico y manejo de las complicaciones pulmonares derivadas de la enfermedad. El objetivo de este artículo es describir las técnicas de imagen y los principales hallazgos imagenológicos observados en la evolución pulmonar de pacientes con COVID-19. La radiografía de tórax, aunque es de fácil acceso, presenta una sensibilidad limitada; mientras que, la tomografía computarizada se ha destacado por su alta precisión, lo cual permite identificar lesiones como la opacidad en vidrio deslustrado y consolidaciones. Estas técnicas no solo ayudan en el diagnóstico inicial, sino también en el seguimiento de la progresión de la enfermedad y en la detección de secuelas a largo plazo. Las técnicas de imagen han demostrado ser una herramienta útil para el diagnóstico y seguimiento del daño pulmonar en pacientes con COVID-19, permiten un manejo más efectivo de los pacientes más vulnerables y mejoran el pronóstico a largo plazo.

Palabras clave

COVID-19, Radiografía Torácica, Tomografía, Infecciones por Coronavirus.

Introduction

The COVID-19 pandemic has left a lasting impact on the health of millions of people worldwide since 2020.[1] Most people who contracted the virus have recovered, and a significant number of patients continue to experience complications, particularly in the respiratory system.

The primary factor associated with hospitalization is being over the age of 65. Other risk factors include cardiovascular disease (CVD), male gender, obesity, diabetes, and chronic kidney disease.[2]

The objective of this review is to describe the imaging techniques and the main radiological findings observed in the pulmonary progression of patients with COVID-19. To this end, a literature review was conducted using databases such as PubMed, Elsevier, and Medline. The search strategy utilized Descriptors in Health Sciences (DeCS) such as "COVID-19," "Chest X-ray," "CT Scan," and "Coronavirus Infections," combined using the Boolean operators AND and OR to identify relevant studies. Articles published between 2020 and 2024, in English and Spanish, that addressed pulmonary radiological findings in patients with SARS-CoV-2 infection were included, selected based on the quality and relevance of the information. Duplicate articles, letters to the editor, and those that did not describe pulmonary imaging evaluation were excluded.

Discussion

COVID-19

COVID-19 is an infectious disease caused by a strain of coronavirus called SARS-CoV-2.[3] It emerged in Wuhan, China, in December 2019. In March 2020, the World Health Organization declared the outbreak a global pandemic.[4] SARS-CoV-2 is the seventh coronavirus identified to date and differs from other coronaviruses that cause the common cold and mild pneumonia.[5]

In many cases, SARS-CoV-2 infection is asymptomatic. A literature review estimated that the proportion of asymptomatic patients is 30 % to 40 %.[6] The symptoms and signs of COVID-19 are nonspecific and clinically indistinguishable from those of other viral respiratory infections. However, the development of dyspnea several days after symptom onset is suggestive of this infection.[3] COVID-19 typically manifests in the lower respiratory tract. Signs and symptoms include fever, dry or productive cough, fatigue, and shortness of breath. Other less common symptoms include myalgia, headache, dysphagia, chills, and gastrointestinal symptoms.[5]

During the first few days, laboratory findings suggest viral lymphocytic pneumonia.[2] In the days that follow, a pro-inflammatory state develops with cytokine release, which contributes to acute lung injury alongside viral damage.[7]

Risk factors

Being over 65 years of age is a significant factor for hospital admission. A case-fatality rate of 8 % to 12 % has been reported among people aged 70 to 79, while it ranges from 15 % to 20 % among those over 80. Likewise, an increased risk of severe disease has been observed in patients with CVD (coronary artery disease, cardiomyopathies, and cerebrovascular disease), diabetes *mellitus*, hypertension, chronic lung disease, cancer (especially hematologic and lung neoplasms), chronic kidney disease, obesity, and smoking.[3,8]

Male gender is also associated with an increased higher risk of serious complications,[9] as is an immunocompromised state, which increases susceptibility to severe forms of the disease. Taken together, these factors are associated with an increased risk of fatal outcomes in adults with COVID-19. Furthermore, radiological diagnosis is essential for assessing the severity of the disease.[10,11]

Diagnosis

The standard test for detecting SARS-CoV-2 is reverse transcription polymerase chain reaction (RT-PCR), typically performed on a nasopharyngeal swab or respiratory secretions. RT-PCR is considered to have high specificity, but its sensitivity can range from 60 % to 70 %.[12]

Laboratory abnormalities associated with a poorer prognosis include: lymphopenia, elevated liver enzymes, elevated LDH, elevated inflammatory markers such as CRP and ferritin, elevated D-dimer levels (> 1 µg/mL), elevated troponin and CPK levels, prolonged prothrombin time, and markers of acute kidney injury. Abnormalities in coagulation tests have also been observed, with a state of hypercoagulability leading to a tendency towards thrombosis.[3]

Diagnostic imaging

Imaging techniques, particularly Thoracic X-rays and computed tomography (CT), are important for detecting lung lesions and assessing their size, density, and progression.[13] Thoracic X-rays aid in triage and the decision to admit a patient, while CT scans, with high sensitivity (98 %), allow for the assessment of the severity, and progression of the disease, revealing key patterns such as ground-glass opacity (GGO).[14]

However, the sensitivity of these tests is limited in the early stages of COVID-19, as up to 18 % of patients have normal Thoracic X-rays or CT scans in mild cases or in the early stages of the disease, but this percentage drops to 3 % in severe cases.[15] Imaging findings can be used to assess the severity of the condition, which aids clinicians in clinical judgment and facilitates effective and rapid treatment.[4]

The current recommendation from the vast majority of scientific societies and radiological associations is that imaging tests should not be used as screening tools for COVID-19, but should be reserved for the evaluation of complications.[16]

For example, the Fleischner Society consensus, published on April 7, 2020, established that imaging studies are not indicated in patients with suspected COVID-19 who present with mild clinical symptoms; on the other hand, they are justified in patients with a confirmed diagnosis of COVID-19 who exhibit respiratory deterioration; likewise, in resource-limited settings, imaging may be used as a triage tool in patients with suspected COVID-19 who exhibit moderate to severe symptoms and have a high prior probability of infection; however, daily Thoracic X-rays are not indicated in stable intubated patients with COVID-19.[17]

Likewise, the Spanish Society of Medical Radiology (SERAM) recommends the use of CT in critically ill patients with a high clinical or laboratory suspicion of COVID-19, who have a normal Thoracic X-ray and for whom a PCR test is difficult to obtain, or who have a negative or inconclusive PCR test; in patients with confirmed COVID-19 who present with clinical deterioration or with suspected pulmonary embolism, superinfection, or the onset of pleural effusion; in patients with critical illnesses and suspected COVID-19 infection; and in those with diagnostic uncertainty where an urgent therapeutic decision is needed, such as in cases of surgery or interventional procedures, to rapidly confirm the diagnosis and ensure adequate protection for the healthcare personnel involved.[3]

Thoracic X-ray

Although it is less sensitive than a Thoracic CT scan, a Thoracic X-ray is usually the first-line imaging technique used in patients with suspected COVID-19.[18]

When the initial Thoracic X-ray is positive, the most common finding is "ground-glass" opacities, which are distributed peripherally and are predominantly located in the lower lobes.[5] Unlike parenchymal abnormalities, pleural effusion is rare (3 %).[18] If the initial follow-up reveals persistent abnormalities on the Thoracic X-ray or clinical deterioration, the evaluation should be supplemented with a high-resolution Thoracic CT scan or a pulmonary artery CT angiogram if thromboembolic complications are suspected.[19]

In the early stages or in mild cases of COVID-19, Thoracic X-rays may not show any abnormalities. However, among hospitalized patients, 69 % already show abnormal findings on admission, and up to 80 % develop radiographic abnormalities at some point during their hospital stay.[18]

Computed tomography

Thoracic CT scans can reveal nearly all abnormalities, including early mild exudative lesions, and are the most valuable imaging tool for the clinical diagnosis of COVID-19 pneumonia.[13] The choice between CT and Thoracic X-ray for the initial diagnosis of a patient should be made by considering the characteristics of each technique and the resources available at each hospital.[19]

Thoracic CT scans in patients with COVID-19 reveal areas of consolidation and GGO, with bilateral peripheral involvement in multiple lobes that progress to "ground-glass" patterns and consolidation.[20] Ground-glass opacities (GGOs) and consolidations have been identified as two of the main signs of COVID-19-related lung lesions on CT scans.[21,22] GGOs are typically distributed peripherally and subpleurally.[23]

Several studies have documented the most common CT findings throughout the clinical course of the disease at different follow-up time points, as summarized in Table 1. These studies agree that diffuse ground-glass opacity (DGG) is the most common CT finding; regardless of the duration of the disease, it may be associated with consolidations and other residual fibrotic changes. Chest CT scan proven to be a valuable tool for assessing lung damage in patients with persistent respiratory symptoms following infection with COVID-19,[24] and remains an essential component of the diagnostic algorithm in patients with suspected SARS-CoV-2 infection.[25]

Main radiological findings and their progression

Opacity of frosted glass refers to the presence of increased, diffuse lung opacity with preserved bronchial and vascular borders.[3] It is the predominant CT finding during the first week.[2] The morphology of the opacities is typically rounded or rectangular, and the zonal distribution in the lung parenchyma occurs predominantly bilaterally andperipherally (93 %) and toward the posterior and lower regions (93 %)[21]. GGO becomes denser (whiter) and progresses to consolidation with complete loss of vascular markings.[32] GGO and consolidation in the pulmonary periphery have been the hallmark of imaging in patients with COVID-19 infection.[33] Patients with mild disease typically show less extensive GGO on CT compared to patients with moderate-to-severe disease; the greatest degree of pulmonary involvement is reached within the first three days and gradually decreases, with nearly complete resolution by 15 days.[34] Figure 1

Consolidation was defined as a homogeneous increase in lung parenchymal attenuation that obscured the margins of the vessels and the walls of the airways; the air-bronchogram sign may be observed, corresponding to patent bronchi surrounded by occupied alveoli. This is the second most common pattern, appearing in association with GGO in 44 % of cases and, less frequently, occurring in isolation in 24 % of cases.[3] As the disease progresses, the opacities tend to increase, cluster, and show greater density on the Thoracic X-ray, evolving into patchy consolidations, with a peak 10-12 days after symptom onset.[2] By the third week, a gradual resolution of the consolidations is observed, with progression back to GGO.[2,22]

The "crazy paving" pattern was defined as ground-glass opacity (GGO) associated with interlobular septal thickening superimposed on an underlying ground-glass pattern, resulting from fluid accumulation in the alveoli and acute inflammation in the pulmonary interstitium.[3] This pattern is a sign of disease progression in COVID-19.[3] The crazy paving pattern is reported with variable frequency, ranging from 15 % to 77 % of patients, with a peak in occurrence during the second week of clinical course;[35] however, the pattern progressively diminishes in the third week. Nevertheless, this radiological finding is rare in the more advanced stages of the disease.[36] Figure 2

Uncommon radiological findings

Inverted halo sign: During the peak of the disease, between days nine and 13, the greatest extent of pulmonary involvement is observed. In this phase, ground-glass opacities (GGOs) progressively evolve into consolidations, which become the predominant finding. Signs such as the inverted halo may also appear, characterized by a central area of ground-glass opacity surrounded by a ring-or crescent-shaped consolidation. Although not a common finding, it has been described as one of the characteristic patterns in certain patients.[3] Figure 3

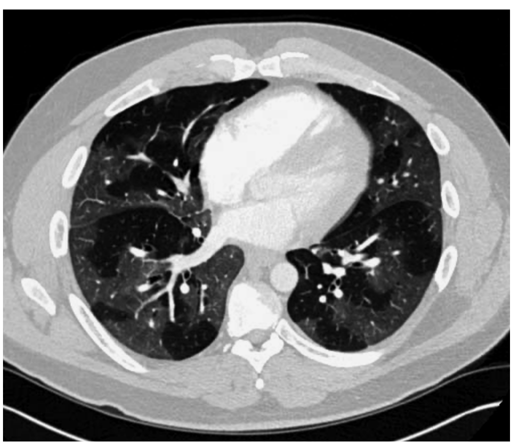

Figure 1. A 35-year-old male patient with acute respiratory distress, showing bilateral irregular ground-glass opacities without consolidation.
Source: Stefan Tigges, Radiopaedia.org, rID: 96156. DOI: 10.53347/rID-96156

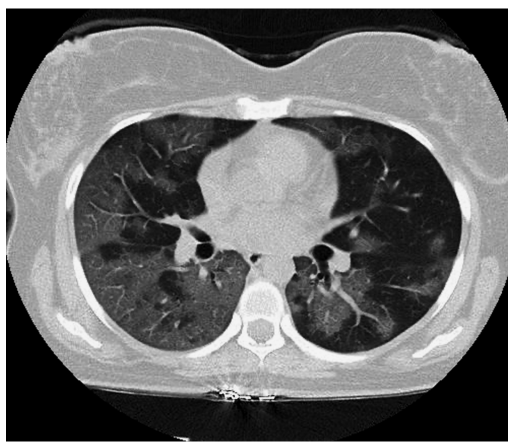

Figure 2. A 40-year-old female patient presenting with fever, cough, and shortness of breath, who tested positive for COVID-19 PCR, showing multifocal, bilateral, irregular, and confluent ground-glass opacities with a "crazy paving" appearance in both lungs.
Source: Bahman Rasuli, Radiopaedia.org, rID: 93230. DOI: 10.53347/rID-93230

Table 1. Comparison of other studies evaluating CT changes in patients with COVID-19

Authors	Follow-up period	CT findings
Guinto E, *et al.*[26]	Three months after COVID-19	GGO, reticulations, bronchiectasis, consolidations
Kumar K, *et al.*[27]	Baseline, 3 and 12 months	GGO, Consolidation
González J, *et al.*[28]	Three months after discharge	Reticulations, Fibrotic lesions
Balbia H, *et al.*[29]	105 days after symptom onset	GGO, reticulations
Han X, *et al.*[30]	Six months after discharge	GGO or Interstitial
Xiaoyu H, *et al.*[31]	Two years after recovery from COVID- 19	GGO, reticulation, atelectasis, bronchiectasis

Figure 3. A 50-year-old female patient presenting with symptoms of cough and shortness of breath, showing multiple irregular, poorly defined opacities, primarily subpleural in both lungs, highly suggestive of COVID-19 pneumonia. The arrow points to the inverted halo sign, characterized by a central ground-glass opacity surrounded by a peripheral ring of consolidation.
Source: Mohammad Taghi Niknejad, Radiopaedia.org, rID: 94808. DOI: 10.53347/rID-94808

Pleural effusion has been reported in only 3 % of patients and is more common in advanced disease.[3] Pleural thickening is the most common finding; it is a late-stage manifestation that typically increases with disease progression and becomes more frequent starting in the second week, peaking in the third week.[35]

Atypical radiological findings

Pericardial effusion, lymphadenopathy, cystic changes, and pneumothorax are some of the less common findings, but they may be observed as the disease progresses since they are often associated with severe cases.[37]

Conclusion

Imaging studies have been essential for the diagnosis, monitoring, and characterization of pulmonary changes in patients with COVID-19. The main abnormalities observed include ground-glass opacities, consolidations, and a crazy paving pattern, the frequency and extent of which vary depending on the stage of the disease. During the clinical course, atypical or infrequent findings are also identified, such as the inverted halo sign, bronchial changes, and pleural effusion, generally associated with more severe cases. The appropriate use of Thoracic X-rays and computed tomography has proven essential, not only in the initial diagnosis but also in follow-up and the detection of long-term sequelae. Recognizing radiological progression in COVID-19 allows for the optimization of clinical care, guides therapeutic decisions, and facilitates the early identification of persistent abnormalities; all of which contribute to comprehensive follow-up and long-term management of affected patients.

Funding

No external funds were received for this work.

References

1. Enríquez Morocho MJ, Rodríguez Bravo LD, Vélez Párraga MS, Orellana Ochoa GA, Tirado Zhingri SD, Verdugo Calle LF, *et al.* Radiografía pulmonar en pacientes con complicaciones post Covid. Polo del Conocimiento. 2023;8(8):4-30. Available at: https://dialnet.unirioja.es/servlet/articulo?codigo=9152330
2. Parra Gordoa ML, Buitrago Weiland G, Grau García M, Arenaza Choperena G. Aspectos radiológicos de la neumonía COVID-19: evolución y complicaciones torácicas. Radiología. 2020;63(74):2-15. DOI: 10.1016/j.rx.2020.11.002
3. Martínez E, Diez A, Ibañez Saez L, Ossaba S, Borruel S. Diagnóstico radiológico del paciente con COVID-19. Radiología. 2020;56(73):2-18. DOI: 10.1016/j.rx.2020.11.001
4. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, *et al.* Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020;(395):1054-1062. DOI: 10.1016/S0140-6736(20)30566-3
5. Obispo I, Silva Costa S, Salvadori C, Itala S, Filho A, Alcántara K, *et al.* O Coração e a COVID-19: O que o Cardiologista Precisa Saber. Arq Bras Cardiol. 2020;114(2):2-12. DOI: 10.36660/abc.20200279
6. Manna A, Osteópata JW, Maron S, Toussie D, Cedillo C, Diamond J, *et al.* COVID-19: A Multimodality Review of Radiologic Techniques, Clinical Utility, and Imaging Features. Radiology. 2020;2(3):1-11. DOI: 10.1148/ryct.2020200210
7. Salehi S, Abedi A, Balakrishnan S, Gholamrezanezhad A. Coronavirus Disease 2019 (COVID-19): A Systematic Review of Imaging Findings in 919 Patients. AJR Am J Roentgenol. 2020;215(1):87-93. DOI: 10.2214/AJR.20.23034
8. Pierre M, Boussouar S, Margerie C, Saab I, Chassagnon G, *et al.* Study of Thoracic CT in COVID-19: The STOIC Project.

Radiology. 2021;301(1):3-10. DOI: 10.1148/radiol.2021210384
9. Shi H, Jiang N, Cao Y, Alwalid O, Fan Y, Zheng C, *et al.* Radiological findings from 81 patients with COVID-19 pneumonia in Wuhan, China: a descriptive study. Lancet Infect Dis. 2020;301(1):9-10. DOI: 10.1016/S1473-3099(20)30086-4
10. Borghesi A, Maroldi R. Radiographic severity index in COVID-19 pneumonia: relationship to age and sex in 783 Italian patients. Radiology. 2020;(125):461-464. DOI: 10.1007/s11547-020-01202-1
11. Yanga Q, Qiangb L, Xudo H, Lud H, Shiyuanmi L, LiF H, *et al.* Imaging of coronavirus disease 2019: A Chinese expert consensus statement. Eur J Radiol. 2020;127(109008):3-7. DOI: 10.1016/j.ejrad.2020.109008
12. Fernández-Pérez GC, Oñate Miranda M, Fernández-Rodríguez P, Velasco Caseres M, Corral C, Lopez F, *et al.* SARS-CoV-2: como es, como actúa y cómo se expresa en la imagen. Radiología. 2020;63(115-126):5-12. DOI: 10.1016/j.rx.2020.10.006
13. Yuen H, Yin H, Ho A, Ting S, Wing T, Shing C, *et al.* Frequency and Distribution of Chest Radiographic Findings in Patients Positive for COVID-19. Radiology. 2020;296(2):5-7. DOI: 10.1148/radiol.202020116
14. Fernandez M, Alarcon J, Ureña A, Matin J, Rigual JA. Manejo y seguimiento del paciente post-COVID-19. Radiología. 2021;63(3):4-12. DOI: 10.1016/j.rx.2021.02.003
15. Garg M, Prabhakar N, Devkota S, Dhooria S, Debi U, Dua A, *et al.* Chest CT findings at six months following COVID-19 ARDS-correlation with the mMRC dyspnea scale and pulmonary function tests. Br J Biomed Sci. 2024;(81):1-9. DOI: 10.3389/bjbs.2024.12871
16. Bernheim A, Mei X, Huang M, Yang Y, Fayad Z, Zhang N, *et al.* Chest CT Findings in Coronavirus Disease-19 (COVID-19): Relationship to Duration of Infection. Radiology. 2020;295(3):5-7. DOI: 10.1148/radiol.2020200463
17. Guinto E, Gerayeli FV, Eddy RL, Lee H, Milne S. Post-COVID-19 dyspnoea and pulmonary imaging: a systematic review and meta-analysis. Eur Respir Rev. 2023;32(169):220253. DOI: 10.1183/16000617.0253-2022
18. Kumar K, Ratnakumar R, Berrocal L. Chest CT features and functional correlates of COVID-19 at 3 months and 12 months follow-up. Clin Med (Lond). 2023;23(5):3-11. DOI: 10.7861/clinmed.2023-0059
19. González J, Benítez D, Carmona P, Monge A, Moncusí-Moix A, Paniello G, *et al.* Pulmonary Function and Radiologic Features in Survivors of Critical COVID-19. Chest. 2021;160(1):3-11. DOI: 10.1016/j.chest.2021.02.062
20. Balbia H, Contido C, Imeri G, Carol A, Surace A, Corsi A, *et al.* Post-discharge chest CT findings and pulmonary function tests in severe COVID-19 patients. Radiology. 2021;138(109676):3-8. DOI: 10.1016/j.ejrad.2021.109676
21. Han X, Fan Y, Alwalid O, Li N, Jia X, Yuan M, *et al.* Six-month follow-up chest CT findings after severe COVID-19 pneumonia. Radiology. 2021;299(1):177-186. DOI: 10.1148/radiol.2021203153
22. Han X, Chen L, Fan Y, Alwalid O, Jia X, Zheng Y, *et al.* Longitudinal assessment of chest CT findings and pulmonary function after COVID-19 infection. Radiology. 2023;307(2):3-9. DOI: 10.1148/radiol.222888
23. Harrison X, Ben H, Xiong Z, Halsey K, Choi J, Linh Tran M, *et al.*Performance of Radiologists in Differentiating COVID-19 from Non-COVID-19 Viral Pneumonia at Chest C. Radiology. 2020;2(296):3-9. DOI: 10.1148/radiol.2020200823
24. Ojha V, Avinash M, Nirmal N. CT in coronavirus disease 2019 (COVID-19): a systematic review of chest CT findings in 4410 adult patients. Eur Radiol. 2020;30(6129):14-30. DOI: 10.1007/s00330-020-06975-7
25. Wang Y, Dong C, Hu Y, Li C, Ren Q, Zhang X, *et al.* Temporal changes of CT findings in 90 patients with COVID-19 pneumonia: a longitudinal study. Radiology. 2020;296(2):4-9. DOI: 10.1148/radiol.2020200843
26. Minhua Y, Dan X, Lan Lan, Mengqi T, Rufang L, Shuhan C, *et al.* Thin-Section Chest CT Imaging of COVID-19 Pneumonia: A Comparison Between Patients with Mild and Severe Disease. Radiology. 2020;2(2):3-8. DOI: 10.1148/ryct.2020200126
27. Hirematha E, Sankar V, Berad K, Lei R, Armitage K. Deep learning reveals lung shape differences on baseline chest CT between mild and severe COVID-19: A multi-site retrospective study. Comput Biol Med. 2024;177(108643):9-11. DOI: 10.1016/j.compbiomed.2024.108643
28. Hania C, Trieua N, Dangearda S, Chassagnona G. COVID-19 pneumonia: A review of typical CT findings and differential diagnosis. Diagn Interv Imaging. 2020;101(5):1-6. DOI: 10.1016/j.diii.2020.03.014
29. Cleverly J, Piper J, Jones MM. The role of chest radiography in confirming COVID-19 pneumonia. BMJ. 2020;370(1):2-3. DOI: 10.1136/bmj.m2426
30. Ming-Yen N, Elaine Y, Yang J, Yang F, Li X, Wang H, *et al.* Imaging Profile of the COVID-19 Infection: Radiologic Findings and

Literature Review. Radiology. 2020;2(1):7-9. DOI: 10.1148/ryct.2020200034

31. Carotti M, Salaffi F, Sarzi-Puttini P, Agostini A, Borgheresi A, Minorati D, *et al.* Chest CT features of coronavirus disease 2019 (COVID-19) pneumonia: key points for radiologists. Radiol Med. 2020;(125):636-646. DOI: 10.1007/s11547-020-01237-4
32. Kanne JP, Little BP, Chung JH, Elicker BM, Ketai LH. Essentials for Radiologists on COVID-19: An Update-Radiology Scientific Expert Panel. Radiology. 2020;296(2):113-114. DOI: 10.1148/radiol.2020200527
33. Raptis CA, Hammer MM, Short RG, Shah A, Bhalla S, Bierhals AJ, *et al.* Chest CT and Coronavirus Disease (COVID-19): A Critical Review of the Literature to Date. American Journal of Roentgenology. 2020;215(4):839-842. DOI: 10.2214/AJR.20.23202
34. Rodrigues J, Hare S, Edey A, Deveraj A, Jacob J, Johnstone A, *et al.* An update on COVID-19 for the radiologist-A British Society of Thoracic Imaging statement. Clin Radiol. 2020;75(5):323-5. DOI: 10.1016/j.crad.2020.03.003
35. Wang YC, Luo H, Liu S, Huang S, Zhou Z, Yu Q, *et al.* Dynamic evolution of COVID-19 on chest computed tomography: experience from Jiangsu Province of China. European Radiology. 2020;30(11):6194-6203. DOI: 10.1007/s00330-020-06976-6
36. Han X, Cao Y, Jiang N, Chen Y, Alwalid O, Zhang X, *et al.* Novel coronavirus disease 2019 (COVID-19) pneumonia progression course in 17 discharged patients: comparison of clinical and thin-section computed tomography features during recovery. Clinical Infectious Diseases 2020;71(15):723-731. DOI: 10.1093/cid/ciaa271
37. Pan F, Ye T, Sun P, Gui S, Liang B, Li L, *et al.* Time course of lung changes at chest CT during recovery from coronavirus disease 2019 (COVID-19). Radiology. 2020;295(3):715-721. DOI: 10.1148/radiol.2020200370