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Detection of Incidental Findings on Chest CT Scans in Patients with Suspected Covid-19 Pneumonia

İlyas Dündar[1*], Sercan Özkaçmaz[1], Fatma Durmaz[1], Leyla Turgut Çoban[1], Gökhan Aygün[1], Ramazan Yıldız[1], Muhammed Bilal Akıncı[1], Ensar Türko[2], Saim Türkoğlu[3],

[1] Department of Radiology, Faculty of Medicine, Van Yuzuncu Yil University, 65080, Van, Turkey
[2] Department of Radiology, Şarkışla State Hospital, 58400, Sivas, Turkey
[3] Department of Radiology, Van Training and Research Hospital, University of Health Sciences, 65080, Van, Turkey

ABSTRACT

This study aimed to evaluate the chest Computed Tomography (CT) scans of COVID-19 suspected patients in the first period of the pandemic, to reveal the frequency of parenchymal-extraparenchymal incidental findings (IFs).

Our single-center retrospective observational study was initiated with the approval of the ethics committee. Chest CT records taken during March-August 2020 due to the suspicion of COVID-19 pneumonia were scanned using the imaging archive of our center. The study was conducted with 1540 patients with non-contrast chest CT without prior CT imaging to detect IFs. Histopathological results and clinical-radiological follow-up data of the patients were scanned from medical records.

Of the 1540 patients in our study, 902 (58.57%) were male and 638 (41.43%) were female, with a mean age of 41.96±17.08 (5-92) years. While 248 (16.1%) patients had a typical appearance for COVID-19 pneumonia on thorax CT, no findings were found in 1180 (76.6%) patients. Except for COVID-19 pneumonia, parenchymal IFs(primary malignant lung lesions, metastatic lesions, benign pathologies) were detected in 73 patients (4.74%) and extraparenchymal IFs(lymphadenopathy, breast lesions, thyroid nodule, bone, liver and kidney lesions...) in 280 patients (18.8%).

Our study showed that the number of patients without any findings in terms of COVID-19 pneumonia on CT scans is high. It is understood that CT scans for pneumonia are unnecessary due to radiation exposure and should be used when clinically necessary. However, due to the ability of CT to detect incidental findings, it is also important to define IFs other than pneumonia in patients who underwent chest CT examination during the pandemic.

Keywords: COVID-19 pneumonia, computed tomography, incidental finding, lung

Introduction

In the last months of 2019, cases of pneumonia due to a new type of coronavirus of unknown etiology and deaths due to severe respiratory distress were reported in Wuhan, China (1). It resulted in the identification of a new type of coronavirus (SARS-CoV-2) as the cause in January 2020, and the name of the disease was accepted as COVID-19 (2). The resulting SARS-CoV-2 spread rapidly around the world, and the associated COVID-19 has become a worldwide threat and health problem. Then it was declared a pandemic by the World Health Organization (WHO) on March 11, 2020 (3–5). Symptoms of COVID-19 range from asymptomatic infection and mild upper respiratory illness to severe pneumonia, acute respiratory distress syndrome (ARDS), multiple organ failure, and death (1,6–8). According to WHO data, the pandemic affected more than 192 million people from its outbreak in China at the end of 2019 to July 2021 and caused more than 4 million deaths worldwide (9).

Computed Tomography (CT) scans are commonly used as a diagnostic tool in the emergency department. Findings that are common in the radiologist's interpretation of these scans, not related to the main complaint, and not related to emergency patient care are classified as "incidental findings (IFs)". Due to the widespread use and high resolution of multislice CTs, the rate of encountering IFs is increasing due to the fact that they reveal previously invisible structures and pathologies in detail. While radiologists focus on the main pathology, they may ignore other pathologies or findings in the cross-sectional area.

***Corresponding Author:** İlyas Dündar MD, Assistant Professor, Van Yuzuncu Yil University, Faculty of Medicine, Department of Radiology, 65080, Campus, Tusba, Van, Turkey
E-mail: dundarilyas262@hotmail.com, Phone: +90 (432) 215 04 70, Fax: +90 (432) 216 85 19
ORCID ID: İlyas Dündar: 0000-0002-1429-077X, **Sercan Özkaçmaz:** 0000-0002-9245-0206, **Fatma Durmaz:** 0000-0003-3089-7165, **Leyla Tugut Çoban:** 0000-0001-7546-6305, **Gökhan Aygün:** 0000-0001-7941-0552, **Ramazan Yıldız:** 0000-0003-3683-0594, **Muhammed Bilal Akıncı:** 0000-0003-2174-962, **Ensar Türko:** 0000 0001 7989 5668, **Saim Türkoğlu:** 0000-0001-8247-2009
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Although these IFs sometimes cause unnecessary further examinations and follow-ups that result in cost and stress burden, they can sometimes cause patients to benefit from the early treatment option (10–15).

We could not find any study examining the rates of IFs in chest CT scans performed for COVID-19 pneumonia in the emergency department during the pandemic. Our aim in this study is to reveal the frequency of parenchymal and extraparenchymal IFs in the lung by retrospectively evaluating the CT scans of patients who were scanned with suspicion of COVID-19 pneumonia in the first period of the pandemic, where CT scans were overused.

Materials and Method

Study Design: This single-center retrospective observational study was initiated with the approval of the medical faculty clinical research ethics committee with a 17.06.2020/20 date/number. In our study, chest CT records taken at the radiology clinic for suspected SARS-CoV-2 pneumonia between March 2020 and August 2020 were retrospectively scanned using the picture archiving and communication systems (PACS) archive of our center. Of the 1748 patients who had chest CT scans, 208 patients with prior chest CT imaging were excluded from the study. The study was conducted with 1540 patients with a non-contrast chest CT without previous CT imaging to detect incidental findings. The histopathological results and clinical or radiological follow-up data of the patients were scanned from electronic medical documents, and the results of the detected incidental lesions of the patients were also investigated.

CT Technique: CT scans were taken with a multi-detector CT device (Somatom Emotion 16-slice; CT2012E-Siemens AG, Germany). The imaging protocol was: 3 mm slice thickness, 0.777 mm reconstruction, 0.6-second gantry rotation, 120 kV tube voltage, 200 mA tube current, and a 40-50 cm field of view. Sections from the lower cervical to the upper abdominal level were obtained without a contrast agent, with the patients in the supine position during CT imaging.

Image Analysis: CT evaluations were performed independently, reaching a consensus, by three radiologists with 15, 12, and 8 years of experience using high-resolution and grayscale workstations. The axial and multi-plane reformatted images were evaluated in mediastinal and parenchymal windows in terms of COVID-19 pneumonia involvement in the lung parenchyma and incidental lesions detected as parenchymal and extraparenchymal, other than COVID-19 pneumonia.

Patients were classified in terms of COVID-19 pneumonia involvement according to the Expert Consensus Statement on the Reporting of Chest CT Findings of COVID-19 pneumonia, accepted by the Thoracic Radiology Association, the American College of Radiology, and the North American Society of Radiology (16). According to this reporting system, four categories have been proposed to report CT imaging findings potentially attributable to COVID-19. The *typical appearance* is the findings (peripheral, bilateral, or rounded morphology multifocal ground-glass opacities (GGO)) that are described frequently and more specifically in COVID-19 pneumonia in the current pandemic in the literature. *Indeterminate appearance* includes findings described in COVID-19 pneumonia but not specific enough (such as round or non-peripheral multifocal, diffuse, perihilar, or unilateral GGO) to reach a relatively reliable radiological diagnosis. *Atypical appearance* is rare or absent findings in COVID-19 pneumonia (such as isolated lobar or segmental consolidation without GGO, discrete centrilobular small nodules, tree-in-bud appearance, cavitation) that are more typical for other diseases. The *negative for pneumonia* refers to the absence of any parenchymal finding that can be associated with infection (16).

Incidental parenchymal findings were classified as malignant-benign lesions and other findings; extra-parenchymal findings were classified as mediastinum, chest wall, axilla, thyroid, bone, and abdomen in the cross-sectional area.

Statistical Analysis: Descriptive statistics for the continuous variables of the study were expressed as mean, standard deviation, minimum and maximum, and categorical variables as numbers and percentages. The SPSS (version 21.0; IBM, Armonk, NY, USA) software package was used for statistical analysis.

Results

Of the 1540 patients in our study, 902 were male (58.57%) and 638 were female (41.43%), and the mean age was 41.96 ± 17.08 (5-92) years. The number of patients aged 5-17 years was 37 (2.4%), and 1503 (97.6%) were 18 years and older. The largest group of adult patients aged between 18-40 years was 802 (52.1%). The number of patients aged 41-65 was 527 (34.2%) and 174 (11.3%) aged

Table 1. Demographic Characteristics of Patients and COVID-19 Pneumonia Involvement Patterns on Chest CT

Variables		
Mean age	41,96 ± 17,08 (5-92)	
Age Distribution	n	%
5-17 age	37	2,4
18-40 age	802	52,1
41-60 age	527	34,2
61-92 age	174	11,3
Gender		
Female	638	41,43
Male	902	58,57
COVID-19 pneumonia involvement patterns		
Typical appearance	248	16,1
Indetermimate appearance	33	2,1
Atypical appearance	80	5,2
Negative for pneumonia	1180	76,6
Total	1540	100

Table 2. Incidental Findings in The Lung Parenchyma on Chest CT

Parenchymal incidental findings	n	%
Primary malignant lesions	2	0,13
Lung synovial sarcoma	1	0,06
Non-small cell lung carcinoma	1	0,06
Metastasis	3	0,19
Hepatocellular carcinoma	1	0,06
Bladder uroepithelial carcinoma	1	0,06
Endometrial carcinoma	1	0,06
Benign Lesions	12	0,77
Solitary pulmonary nodule	8	0,52
Hamartoma	2	0,13
Tuberculosis	1	0,06
Air cyst	1	0,06
Other findings	56	3,64
Atelectasis	26	1,69
Emphysema	12	0,78
Azygos lobe variation	7	0,45
Bronchiectasis	5	0,32
Mosaic perfusion	4	0,26
Pleural calcification	2	0,13
Total	73	4,74

66-92. Of the 1540 patients, 248 (16.1%) had a typical appearance for COVID-19 pneumonia on chest CT, 33 (2.1%) had an indeterminate appearance, and 80 (5.2%) had an atypical appearance. In 1180 (76.6%) of the patients, no findings were found in chest CT in terms of COVID-19 pneumonia (Figure 1, Table 1).

Except for COVID-19 pneumonia, Parenchymal IFs were detected in a total of 73 patients (4.74%).

Table 3. Extraparenchymal Incidental Findings on Chest CT

Extraparenchymal incidental findings	n	%
Mediastinum	127	8,25
Cardiomegaly	71	4,61
Lymphadenopathy	48	3,12
Pericardial effusion	8	0,52
Chest wall-axilla	31	2,01
Axillary lymphadenopathy	25	1,62
Breast mass	6	0,38
Thyroid	34	2,21
Solitary nodule	31	2,01
Multinodular goiter	3	0,19
Bone	27	1,75
Degenerative changes	21	1,36
Vertebral hemangioma	5	0,32
Metastasis	1	0,06
Abdomen entering the cross-sectional area	61	3,96
Nephrolithiasis	23	1,49
Cholelithiasis	16	1,04
Hypodense lesion in the liver	10	0,65
Hydatid cyst in the liver	9	0,58
Adrenal adenoma	2	0,13
Metastasis	1	0,06
Total	280	18,18

While primary malignant lung lesions (1 lung synovial sarcoma, 1 non-small cell lung carcinoma) were detected in a total of 2 patients (0.13%) (Figure 2); metastatic lesions (1 hepatocellular carcinoma, 1 bladder uroepithelial carcinoma, 1 endometrial carcinoma) were observed in a total of 3 patients (0.19%) (Figure 3). Benign lung lesions (8 solitary pulmonary nodules, 2 hamartomas, 1 tuberculosis, 1 air cyst) were detected in a total of 12 patients (0.77%). In addition, other findings were found in a total of 56 patients (3.64%) (Table 2).

Extraparenchymal IFs were detected in a total of 280 (18.8%) patients. The most common IFs were cardiomegaly (n=71, 4.61%) and lymphadenopathy (n=48, 3.12%) in 127 patients (8.25%) seen in the mediastinum. Axillary lymphadenopathy in 25 patients (1.62%), and 1 cystic and 5 solid lesions in the breast in 6 female patients (0.38%) were detected. While 3 of the solid breast lesions were diagnosed as histopathological fibroadenoma, 2 were benign lesions that did not show any difference in clinicoradiological follow-ups but had no histopathological diagnosis. There were 34 (2.21%) IF in the thyroid tissue, of which 31 were solitary nodules and 3 multinodular goiters. There were 27 (1.75%) findings, including 21 degenerative changes in bone structures, 5 vertebral hemangiomas, and 1 metastasis (non-small cell lung carcinoma). Nephrolithiasis (n=23, 1.49%), cholelithiasis (n=16, 1.04%) were the most common IF detected in a total of 61 patients (3.96%) in the abdomen entering the cross-sectional area, while metastasis in the liver (lung synovial sarcoma) was seen in 1 patient. Extraparenchymal IFs are written in more detail in table 3.

Discussion

The demonstration of ribonucleic acid related to SARS-CoV-2 by reverse transcriptase-polymerase chain reaction (RT-PCR) in secretions of the patients such as throat and nose swab and tracheal aspirate material is the gold standard in the diagnosis of COVID-19 (1,17). However, while the specificity of RT-PCR for the diagnosis of COVID-19 is high, its sensitivity is relatively low (18). Especially in the initial period of the

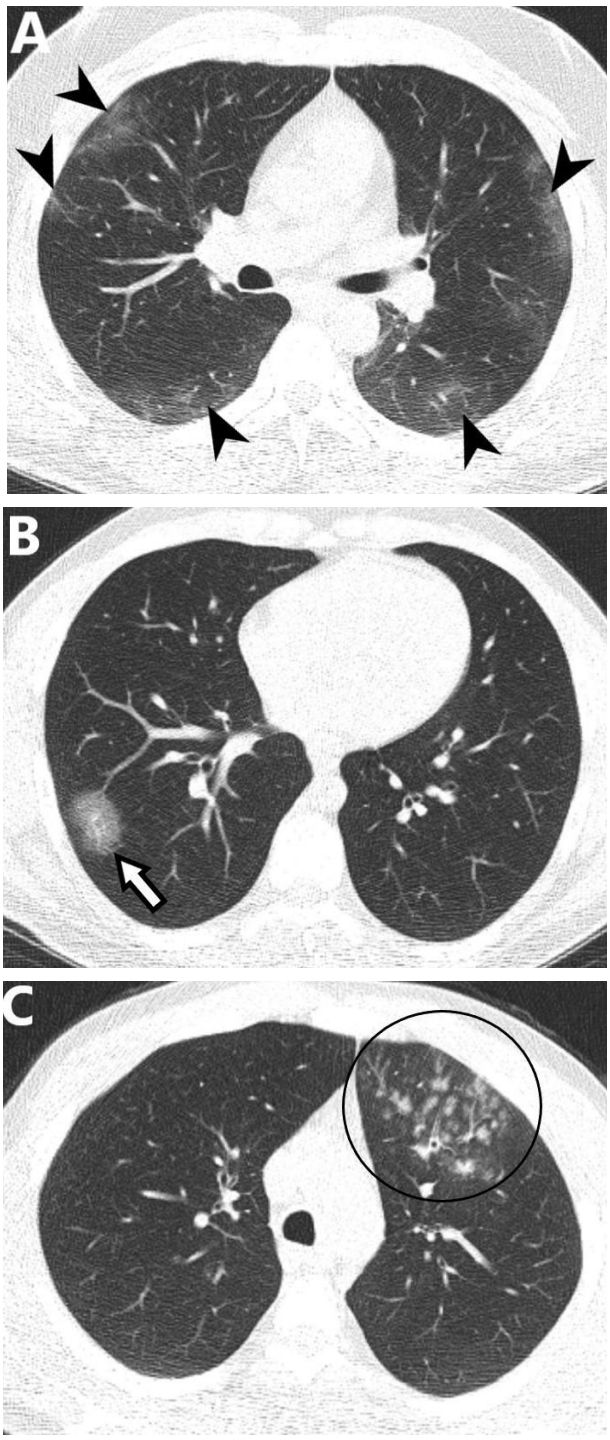

Fig. 1. In parenchyma windows of chest CT; **A.** Bilateral peripheral ground-glass opacities (arrowheads) in a 40-year-old male patient, typical appearance in terms of COVID-19 pneumonia. **B.** A unilateral peripheral ground-glass opacity (arrow) in the posterolateral right lung lower lobe in a 31-year-old male patient, undeterminate appearance in terms of COVID-19 pneumonia. **C.** In a 36-year-old male patient, tree-in-bud appearances (circle) suggesting mostly bacterial pneumonia in the anterior upper lobe of the left lung, atypical appearance in terms of COVID-19 pneumonia.

pandemic, radiological imaging methods have started to be used intensively because of the inability to perform the test in some centers, the prolongation of the test results, and the fact that they can show false negativity in the early period (19,20). Therefore, the number of patients with respiratory symptoms who underwent CT for suspected COVID-19 pneumonia rapidly increased during the pandemic. In order to reduce the risk of transmission, especially in the first period of the pandemic, the radiology department of our institution reserved one CT unit for all suspected COVID-19 infections, and another CT unit continued to evaluate other patients. CT was used as a screening test for COVID-19 pneumonia in our institution, especially in the first period of the pandemic, for the reasons mentioned above.

In this study, we decided to investigate the IFs due to a large number of CT scans. In the literature, CT should not be used as a screening test in the diagnosis of COVID-19 because of ionizing radiation; It has been reported that it should be used as a problem-solving method in patients whose RT-PCR test is negative but clinically indeterminate (19,21). In our study, most of which consisted of young patients (5-40 years, 54.5%); while 248 (16.1%) of 1540 patients who underwent CT scans had a typical appearance in terms of COVID-19 pneumonia; 1180 of the patients (76.6%) had no findings. The results of our study support that the use of CT scans for the detection of COVID-19 pneumonia is unnecessary, it increases the radiation exposure of especially young patients and should be used when clinically necessary.

CT scans are increasingly used in the emergency department (10). In addition, advances in the technology of CT scanners in many institutions have caused radiologists to evaluate CTs in more detail and have increased their ability to reveal IFs. Some of these IFs are benign and do not require follow-up, while others require further investigation and treatment (13,15,22). To our knowledge, our retrospective study is the first to address the distribution of IFs on chest CT scans using for COVID-19 pneumonia diagnosis during the pandemic. In our study, excluding COVID-19 pneumonia; parenchymal IFs were detected in a total of 73 patients (4.74%)and extra-parenchymal IFs were detected in a total of 280 (18.8%) patients. While further examination and follow-up were performed for a total of 231 (15%) patients among these patients; A total of 122 (7.9%) patients did not require further investigation due

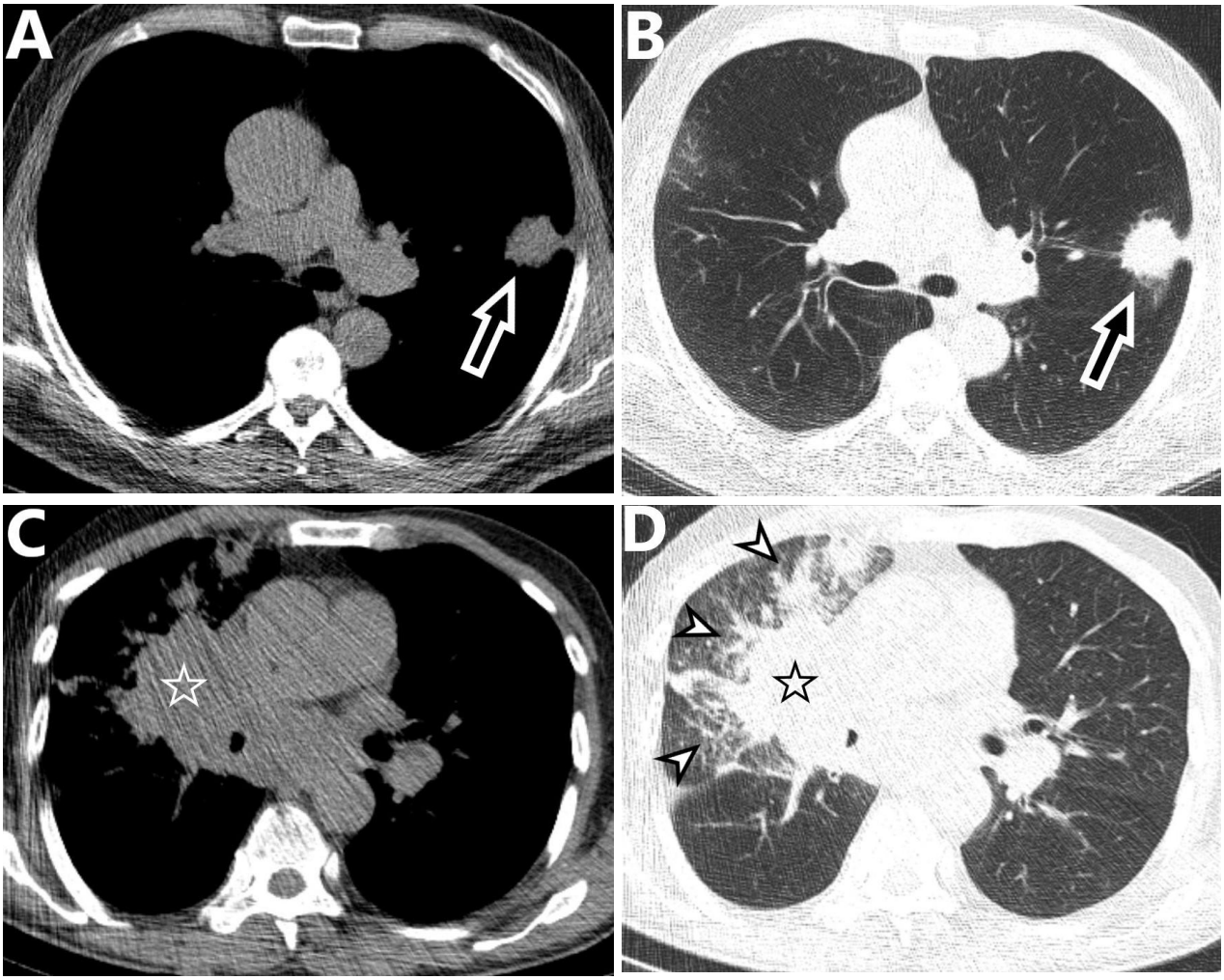

Fig. 2. A-B. In a 61-year-old male patient; The pathology result of a spiculated contoured mass lesion (arrow) measuring approximately 3.5 cm in mediastinum and parenchymal windows in the apicoposterior of the left lung upper lobe was synovial sarcoma. **C-D.** In a 61-year-old male patient; The pathology result of a spiculated contoured mass lesion (arrow) measuring approximately 6.5 cm, with lymphangitic extensions around it (arrowheads), extending from the right lung hilar region to the upper and middle lobes in the mediastinal and parenchymal windows, narrowing the bronchi at this level, was non-small cell lung carcinoma.

to benign findings. Malignant etiologies were detected in 5 patients (0.32%) out of 231 patients who were investigated and followed up; benign causes were found in other patients.

In a retrospective study conducted with a large autopsy series in which incidental findings were investigated, primary lung cancer was detected in 0.87% of the cases (217/24.708) (23). In another study investigating the frequency of incidental findings in CT scans for lung cancer screening, the primary lung was diagnosed in 0.62% (2/320) of patients with lung lesions (12). In the chest CT scans performed with 633 workers exposed to asbestos, 5 patients (0.79%) had primary lung cancer (13). In our study, two different patients (0.13%) had primary lung carcinoma (1 lung synovial sarcoma, 1 non-small cell lung carcinoma) as a result of CT-guided transthoracic biopsy of incidentally detected lung lesions. We think that the rates were lower in our study because the patients who were screened were younger and patients with suspected pneumonia were screened rather than patients with certain risk factors for cancer. In addition, there were 3 patients (0.19%) in our study, whose primary was known before, but whose lung metastases were detected incidentally and confirmed pathologically.

In one of the largest studies reviewing CT scans, it was stated that due to the heterogeneity of the different types of screening studies, the aggregation of all data does not contribute to a complete assessment of IFs (14). In that study, which reviewed 10 CT scan studies, the incidence of pulmonary nodules was reported as 0.44%-19%

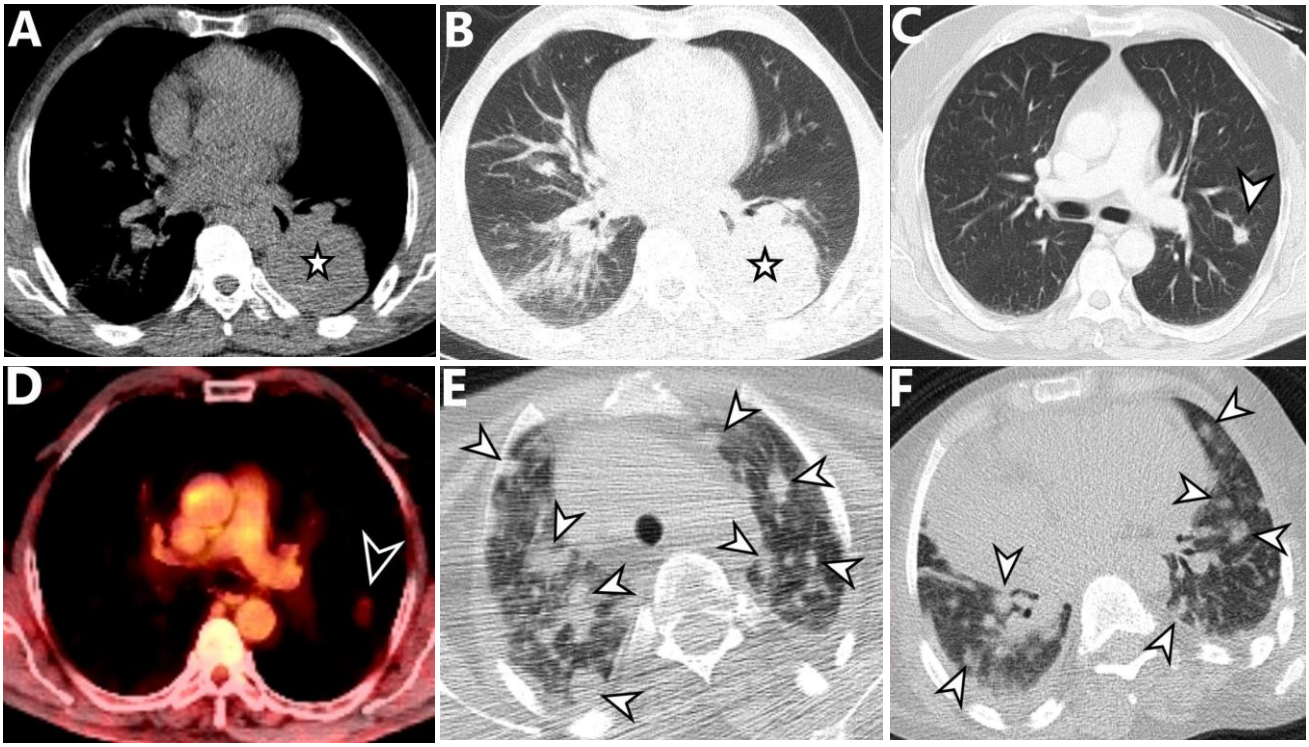

Fig. 3. A-B. In a 63-year-old male patient with hepatocellular carcinoma; A solid mass lesion (star) of approximately 7.5 cm in the left lung lower lobe superior to the mediastinum and parenchyma windows was diagnosed as metastasis. **C-D.** In a 67-year-old male patient with bladder uroepithelial carcinoma; Metastatic nodule (arrowheads) approximately 1.5 cm in size in the apicoposterior of the left lung upper lobe in the parenchymal window (C), showing pathological FDG uptake on PET-CT (D) taken later. **E-F.** In a 46-year-old female patient with a diagnosis of endometrial carcinoma; Multiple metastatic nodules (arrowheads), the largest approximately 2 cm in size, randomly located in the upper and lower zones of the parenchymal windows

(14). In our study, the frequency of benign pulmonary nodules in clinicoradiological follow-ups was 0.52%, which was similar to the study of Hunold et al. (15). In addition, in our study, there were 2 hamartomas, 1 tuberculosis, and 1 air cyst in our benign lung lesions. In the CT scans performed for lung cancer by Morgan et al., IF was detected in 69.6% of the patients (n=223) in the respiratory system. Among these findings, the most common ones were emphysema (50.6%), bronchial wall thickening (39.4%), and atelectasis (16.3%) (12). In the study of Jacobs et al., the frequency of bronchiectasis was 0.72-9.8% (14). In our study, the most common parenchymal findings were atelectasis (1.69%), emphysema, azygos lobe variation, and bronchiectasis (Table 2). Our findings showed a heterogeneous distribution similar to those in the literature.

In the study of Morgan et al., mediastinal lymphadenopathy was found in 2.8%, adrenal nodule in 3.8%, thyroid nodule in 3.4%, liver cyst in 6.8%, gallbladder stone in 1.9%, and kidney stone in 1.3% (12). In the study of Jacobs et al., mediastinal lymphadenopathy 0.13-3.0%, breast lesions 005-1.38%, pericardial disease 0.05-0.59%, thyroid disease 0.4-3.1%, liver disease 0.07-9.1%, adrenal mass 0.05-3.1%, and kidney stones were at a rate of 1.6% and showed a very heterogeneous distribution (14). In our study, mediastinal lymphadenopathy was 3.12%, pericardial effusion 0.52%, breast lesion 0.38%, thyroid nodule 2.21%, kidney stone 1.49%, gallbladder stone 1.04%, hypodense lesion in the liver 1.23%, and adrenal lesion 0.13% were similar to the literature. Other findings in our study are listed in Table 3.

There are some limitations of our study such as relatively small sample size, single-center, short observation period, and retrospective nature. Including more patients would undoubtedly increase the strength of the study. However, considering the current working conditions due to the pandemic, it was not possible to increase the number of patients in the study, as it made difficult the evaluation of CTs and patient follow-up.

In conclusion, our study shows that the rate of patients (76.6%) without any finding in terms of pneumonia in CT scans performed for COVID-19

in the emergency department is high. Our study shows that CT scans for pneumonia are unnecessary due to radiation exposure and should be used when clinically necessary. However, due to the high resolution of CT scans, its ability to capture IFs, whether relevant or not, cannot be ignored. It is also important to define IFs other than pneumonia in patients who underwent chest CT scans during the pandemic. The CT scans of the patients with a suspicion of COVID-19 must be detailed examined regarding also extra parenchymal findings in various structures such as chest wall, breast, bone, and intraabdominal solid organs to detect incidental findings especially malignant conditions. Therefore, radiologists play a critical role in the management of COVID-19, as early imaging of both clinically relevant and IFs can significantly affect disease behavior and prognosis.

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