

Evaluation of Non-COVID-19 CT Scan Findings Detected on CT Images Performed due to Suspected COVID-19 Pneumonia: A Retrospective Analysis of 6669 Cases

COVID-19 Pnömonisi Şüphesiyle Yapılan Bilgisayarlı Tomografi Görüntülemesinde Saptanan COVID-19 Dışı Bulguların Değerlendirilmesi: 6669 Vakanın Restrospektif Analizi

İD Sevim Özdemir¹ İD Rüştü Türkay¹ İD Bahar Atasoy Badur² İD Tuba Selçuk Can¹
İD Behice Kaniye Yılmaz¹ İD Türkan İkizceli¹ İD Nurdan Göçgün¹

1- Health Sciences University, Istanbul Haseki Training and Research Hospital, Department of Radiology, Istanbul, Türkiye
2- Bezmialem Vakıf University, Medical Faculty, Department of Radiology, Istanbul, Türkiye

ABSTRACT

Objective: For the past years, COVID-19 infection has continued to play a significant role in our lives as a serious threat and concern due to increase in the number of cases. During this pandemic stage, chest computed tomography (CT) has been proven to have great importance for rapid and accurate diagnosis and a pivotal role in assisting the clinical management of patients with uncertain clinical scenarios.

The present retrospective study aimed to inform the clinicians who referred chest CT and the radiologists reporting these CTs about the frequency and variety of non-COVID-19 findings in patients who underwent chest CT examination with the suspicion of COVID-19 pneumonia.

Material and Method: This retrospective study was approved by our Institutional Ethics Committee. The requirement for written informed consent was waived. Our study included 6669 patients who applied to the emergency room with the suspicion of COVID-19 infection between March 20th and April 20th, 2020. The inclusion criteria were patients who had suspicious symptoms of having COVID-19 infection and/or had close contact with a patient with COVID-19 infection and (ii) patients who underwent chest CT. They evaluated CT scans individually, and all non-COVID-19 findings (NCF) were recorded manually.

Results: The study population consisted of 6669 consecutive patients (males 55.5% and females 44.5%). The overall mean age was 41.7 years [SD±15.1]. There were incidental non-COVID-19 findings in 3159 (47.4%) patients and none in 3510 (52.6%) patients.

Conclusion: CT examinations performed in patients with suspected COVID-19 pneumonia should be examined in detail regarding clinically significant findings. It is vital to take necessary precautions in advance regarding pathologies that may be clinically significant regarding appropriate treatment and follow-up planning at the appropriate time. The clues must be stated in the radiology report so that the clinician can make appropriate management regarding these pathologies.

ÖZET

Amaç: Birkaç yıldır, vaka sayılarının artmasıyla birlikte ciddi bir tehdit ve endişe kaynağı olarak COVID-19 enfeksiyonu hayatımızda önemli bir rol oynamaya devam etmektedir. Bu pandemi aşamasında toraks bilgisayarlı tomografisinin (BT) hızlı ve doğru tanı açısından büyük öneme sahip olduğu ve belirsiz klinik senaryolara sahip hastaların klinik yönetimine yardımcı olmada önemli bir role sahip olduğu kanıtlanmıştır. Bu retrospektif çalışmada, COVID-19 pnömonisi şüphesiyle toraks BT incelemesi yapılan hastalarda, toraks BT'ye yönlendiren klinisyenlere ve bu BT'leri raporlayan radyologlara, COVID-19 dışı bulguların sıklığı ve çeşitliliği hakkında bilgi verilmesi amaçlandı.

Gereç ve Yöntem: Bu retrospektif çalışma kurumsal etik kurulumuz tarafından onaylandı. Yazılı bilgilendirilmiş onam alma zorunluluğundan feragat edildi. Çalışmamıza 20 Mart- 20 Nisan 2020 tarihleri arasında acil servise COVID-19 enfeksiyonu şüphesiyle başvuran 6669 hasta dahil edildi. Dahil edilme kriterleri, COVID-19 enfeksiyonuna dair şüpheli semptomları olan ve/ya yakın temasta COVID-19 enfeksiyonlu bir hastaya yakın teması olan hastalar ve toraks BT çekilen hastalardı. Toraks BT tetkikleri değerlendirildi ve COVID-19 dışı tüm bulgular manuel olarak kaydedildi.

Bulgular: Çalışma popülasyonu ardışık 6669 hastadan oluşmuştur (%55.5 erkek ve %44.5 kadın). Genel ortalama yaş 41,7 yıl idi. 3159 (%47.4) hastada rastlantısal olarak COVID-19 dışı bulgular görüldü, 3510 (%52.6) hastada ise COVID-19 dışı bulgu yoktu.

Sonuç: COVID-19 pnömonisi şüphesi olan hastalarda yapılan toraks BT incelemeleri klinik açıdan anlamlı bulgular açısından ayrıntılı olarak incelenmelidir. Klinik açıdan anlamlı olabilecek patolojilerde gerekli önlemlerin önceden alınması, uygun zamanda tedavi ve takip planlaması yapılması hayati önem taşımaktadır. Klinisyenin bu patolojilere yönelik doğru yönetimi yapabilmesi için ipuçlarının radyoloji raporunda belirtilmesi önemlidir.

Keywords:

Incidental Finding
Computerized Tomography
X-Ray

Anahtar Kelimeler:

Rastlantısal Bulgular
Bilgisayarlı Tomografi
X-Ray

Correspondence: Sevim Özdemir, Istanbul Haseki Training and Research Hospital, Department of Radiology, Uğur Mumcu, Atatürk BLV no: 54 Postcode: 34265 Sultangazi/Istanbul. **E-mail:** sevimozdemir76@yahoo.com

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INTRODUCTION

For about a few years, COVID-19 infection has continued to play a significant role in our lives as a serious threat and concern with the increase in the number of cases (1-3). During this pandemic stage, chest computed tomography (CT) has been proven to have great importance for rapid and accurate diagnosis and a pivotal role in assisting the clinical management of patients with uncertain clinical scenarios. Although the American College of Radiology (ACR) and other professional radiology societies have suggested against considering CT as a screening tool in the diagnosis of COVID-19, rapid and accurate diagnostic tools are urgently needed to identify, isolate, and manage the treatment of the patients as soon as possible (4). Although the specificity of the Polymerase Chain Reaction (PCR) results is high, performing imaging examination, especially chest CT, is necessary since serologic tests have some drawbacks, such as the long turnaround time and false negative test results (5). In the chest CT evaluation, the neck and upper abdominal organs, as well as the lung parenchyma and mediastinal structures, are displayed, and abnormalities of these regions can also be evaluated. As the role of CT imaging and the number of CTs for diagnosing COVID-19 pneumonia increases, more additional CT findings other than COVID-19 pneumonia are detected. In some patients, this may be beneficial in the early detection and prevention of abnormalities that are not initially clinically suspected yet urgent for diagnosis and treatment. Several recent studies have characterized CT imaging features of COVID-19 and reported the performance of radiologists in discriminating COVID-19 pneumonia from other viral etiologies. The described typical imaging patterns are bilateral, multifocal, and predominantly peripheral ground-glass opacities (GGO) associated with sub-segmental and mostly subpleural patchy consolidations, predominantly involving the lower lung lobes and posterior segments (6-9). The present retrospective study aimed to inform the clinicians who referred chest CT and the radiologists reporting these CTs about the frequency and variety of non-COVID-19 findings in patients who underwent chest CT examination with the suspicion of COVID-19 pneumonia.

MATERIAL AND METHOD

Sample and Data Collection

Our study included 6669 patients who applied to the emergency room with the suspicion of COVID-19 infection between March 20th and April 20th, 2020, and were referred to the radiology department as a result of the first clinical evaluation and underwent CT examination. The inclusion criteria were (i) patients who had suspicious symptoms of having COVID-19 infection and/or had close contact with a patient with COVID-19 infection and (ii) patients who underwent chest CT.

Ethical Consideration

This retrospective study was approved by our Institutional Ethics Committee (Date: 19.08.2020; Number: 2020-132). The requirement for written informed consent was waived.

CT Scanning Protocol

CT data were acquired using a 128-detector CT scanner (PHILIPS Ingenuity, Netherlands). The parameters of the

CT scan were as follows: the patient was in the supine position and end-inspiratory acquisition, tube current–exposure time product of 200–300 mAs, tube voltage of 120 kV, and section thickness after reconstruction of 1.25 mm. CT scanning extended from the thoracic inlet to the caudally, including the upper abdomen. CT scans were obtained without contrast material administration.

Imaging Data Analysis

CT images were retrospectively evaluated by six radiologists with 5-20 years of experience in thoracic radiology who were blinded to RT-PCR test results. They evaluated CT scans individually, and all non-COVID-19 findings (NCF) were recorded manually. NCFs were classified into five groups, similar to the Computerized Tomography-Colonography Reporting and Data System (C-RADS) (10) (Table 1). Each group was classified according to its clinical significance. Groups NCF1 and NCF2 were combined as clinically insignificant findings, and groups NCF3 and NCF4 were combined as clinically significant finding groups. NCF0 was stated for limited examination due to severe artefacts or operation materials.

Table 1: Non-COVID-19 finding groups

GROUPS	DESCRIPTION	EXAMPLE
NCF0	Limited examination: compromised by artefacts or operation materials.	Artefact, sternotomy, valve replacement, intracardiac device
NCF1	Anatomic variations	Aberrant right subclavian artery, azygos fissure and lobe
NCF2	No clinically suspected finding: no workup indicated	Pulmonary fibrotic bands, simple renal cyst, simple liver cyst, renal calculus, gallstone
NCF3	Probably insignificant findings, incompletely characterized: workup may be indicated	Coronary calcification, cardiomegaly, hepatomegaly
NCF4	Probably significant findings: communicate to referring physician as per accepted practice guideline	Aortic aneurysm, aortic dissection, pulmonary mass, hydronephrosis

NCF: Non-COVID-19 Findings

Statistical Analysis

The statistical analysis was performed with SPSS software version 15.0. Descriptive statistical methods (mean, standard deviation, frequency, and percentage), Chi-square test, and Fisher’s exact test were used for categorical variables, and Student t-test and Mann-Whitney U test were used for continuous variables in two group comparisons. Results were evaluated in a 95% confidence interval, and the statistical significance was accepted as $p < 0.05$.

RESULTS

The study population consisted of 6669 consecutive patients (3701 males (55.5%) and 2968 females (44.5%)). The overall mean age was 41.7 years (SD 15.1); range 0-94 years, being 42.5 years (SD 15.7); range 0-94 for women and 41.1 years (SD 14.4); range 1-90 years for

Frequency of NCF groups

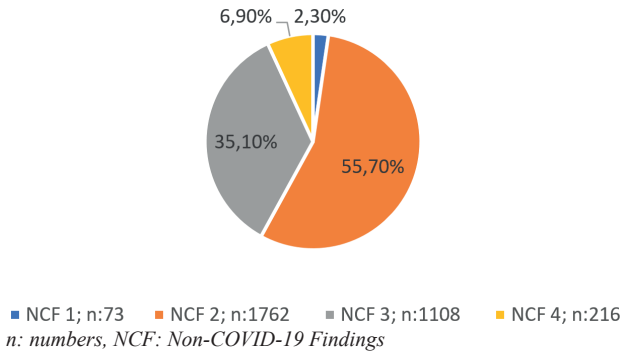
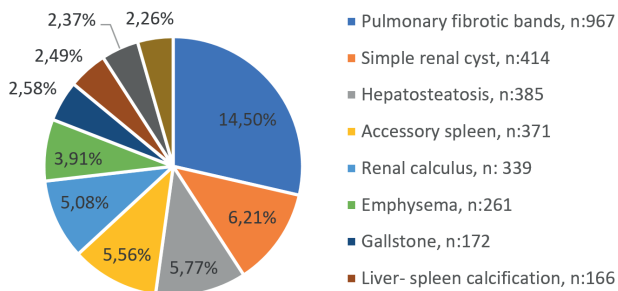


Figure 1: The distribution of non-COVID findings.

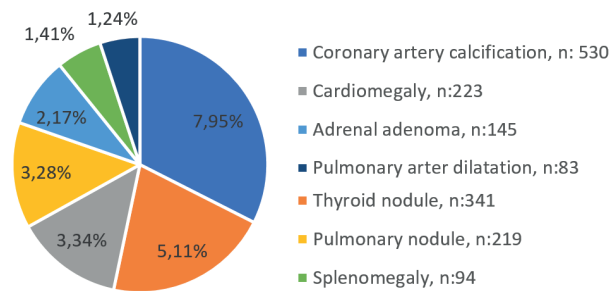
NCF 2



NCF: Non-COVID-19 Findings

Figure 2: Findings in the NCF2 group.

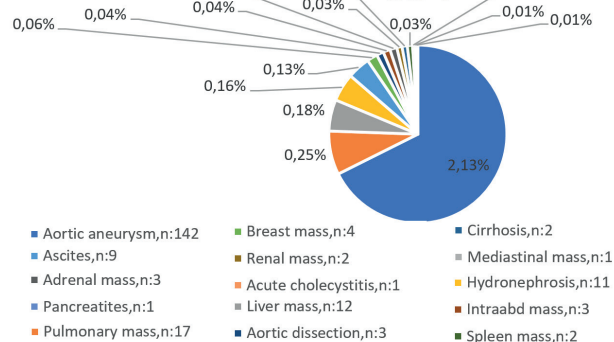
NCF 3



NCF: Non-COVID-19 Findings

Figure 3: Findings in the NCF3 group.

NCF 4



NCF: Non-COVID-19 Findings

Figure 4: Findings in the NCF4 group.

Table 2: The distribution of clinically insignificant and significant groups by gender and age

	NCF1-NCF2 n (%)	NCF3-NCF4 n (%)	p-value
Gender (n=3159)			
Female	716 (54.3)	603 (45.7)	<0.001
Male	1119 (60.8)	721 (39.2)	
Mean (min-max) Mean (min-max)			
Age	44 (2-93)	55 (3-94)	<0.001

NCF: Non-COVID-19 Findings

men. There were incidental non-COVID-19 findings in 3159 (47.36%) patients and none in 3510 (52.6%) patients. Figure 1 summarizes the frequency of NCF groups.

We classified NCF1 and NCF2 as the clinically insignificant groups and NCF3 and NCF4 as the clinically significant groups. The distribution of clinically insignificant and significant groups by gender and age is presented in Table 2. The mean age was 44.27±12.9 and 54.18±15.2 years in clinically insignificant and significant groups, respectively. This difference was statistically significant (p<0.001). The mean age was 35.73±12.6 years for patients without an incidental non-COVID-19 finding. The mean age was significantly higher in patients with an NCF (p<0.001). When the patient groups with and without NCFs were compared regarding gender, no significant difference was determined (p=0.885). Clinically insignificant NCFs were detected statistically more in both genders when compared to the clinically significant groups (p<0.001). Within the NCF1 group, the most common anatomic variants were azygos fissure-lobe in 62 patients (0.93%) and retroaortic left renal vein in 49 (0.7%), respectively.

Findings in the NCF2 group are summarized in Figure 2. The most common findings in this group were fibrotic bands in the lung in 967 patients (14.5%), simple renal cysts in 414 patients (6.21%), and hepatosteatosi in 385 patients (5.77%).

Findings in the NCF3 group are shown in Figure 3. The most common findings in this group were coronary artery calcification in 530 patients (7.95%), thyroid nodules in 341 patients (5.11%), and cardiomegaly in 223 patients (3.34%).

Findings in the NCF4 group are presented in Figure 4. The most common findings in this group were aortic aneurysm in 142 patients (2.13%), pulmonary mass in 17 patients (0.25%), liver mass in 12 patients (0.18%), hydronephrosis in 11 patients (0.16%), and ascites in 9 patients (0.13%).

DISCUSSION

Several research papers have been recently published in the literature to describe characteristic CT imaging features and the temporal evaluation of imaging findings in patients with COVID-19 (6-9). Ai et al. reported the complementary role of chest CT in cases with false-negative RT-PCR test results, stating that the sensitivity of chest CT imaging was 97% in RT-PCR-confirmed cases (11). In a meta-analysis, the rate of positive chest CT imaging for pneumonia among patients suspected

of COVID-19 was determined as 89.76% (12). These findings emphasize the importance of CT imaging, especially in clinically suspected patients with negative test results.

As reported in the study of Dündar et al., CT was used as a screening method in some centers (13). Although CT is not used as a screening tool in patients with clinical suspicion of COVID-19 in our hospital, it has become a frequently used diagnostic aid due to the limited access to RT-PCR tests and the prolonged time required for the test results, especially in the early stages of the pandemic. For this reason, one of the CT units had been reserved for these patients in our clinic, as reported in the literature, within the scope of measures taken to reduce the risk of disease transmission.

CT is not a harmless diagnostic tool due to its high radiation doses, and CT has been overused in this process. As in routine, these CT examinations performed during the COVID-19 pandemic were evaluated and reported by radiologists. Since each examination performed was evaluated as a whole, every organ and anatomical structure in the imaging area was examined as well as lung findings. According to the definition of the ACR, an incidental finding, also known as an incidentaloma, can be defined as an incidentally discovered mass or lesion detected by CT, Magnetic Resonance Imaging (MRI), or other imaging methods performed for an unrelated reason (14). While these incidental findings are sometimes early diagnoses for the patients and save a life, they can occasionally lead to unnecessary further investigations.

For these reasons, it is crucial to identify and report clinically significant NCFs. In the study conducted by Turkay et al. on the extracolonic findings obtained in 227 patients in the CT colonography examination, it was stated that most of the findings were clinically insignificant at the time of reporting, the importance of the pathology and recommendations should be noted clearly and in close contact with the referring clinician (15). In addition, it was reported in this study that incidental findings, especially in asymptomatic patients, were the subject of discussion, the findings were irrelevant to the clinic, and the duration of evaluation and follow-up increased patient anxiety and cost.

In our study, some incidental findings were also detected in these chest CTs taken for COVID-19 disease. A total of 3159 patients (47.36%) had NCFs. Clinically significant NCFs were detected in 1324 patients (19.85%). Similar to some studies in the literature, in our study, clinically significant findings were less common than clinically insignificant findings (16,17).

Various studies have demonstrated that COVID-19 pneumonia is more common in men. In Khan's study, men were predominantly infected (70.25%), similar to Yang's meta-analysis (18,19). In terms of NCFs, no statistically significant difference was determined according to gender in patients with clinically significant or insignificant NCFs in our study.

When the NCFs were analyzed according to age, the frequency of the findings increased statistically significantly with age. Van Vugt et al., in a European-

centered study in which chest radiographs were scanned due to acute cough, revealed that incidental findings were more common in elderly patients (20). In our study, incidental findings were detected more in elderly patients, similar to Van Vugt et al.'s study.

In the literature, it has been reported that there is abundant evidence that most cases of mortality develop in COVID-19 patients with cardiovascular disease (21). Therefore, additional examinations on COVID-19 patients with cardiovascular diseases are vital for optimal management. In a study, cardiomegaly was detected on chest CT scan in 33 (26.8%) patients (21). In our study, the most common finding among the clinically significant group was coronary artery calcification, with a rate of 7.94%. The other most common clinically significant findings were thyroid nodules (5.11%), cardiomegaly (3.34%), pulmonary nodules (3.28%), adrenal adenoma (2.17 %), aortic aneurysm (2.12%), and splenomegaly (1.4%) respectively. The study by Gupta et al. reported that COVID-19 patients with any coronary artery calcification were more likely to require intubation and die than those without coronary artery calcification (22). Furthermore, increasing coronary artery calcification was associated with mortality (22). Pre-existing cardiovascular disease may increase vulnerability to COVID-19 and greatly influence pneumonia development and prognosis. It should also be noted that the secondary damage of the virus is on the cardiovascular system (22). For this reason, viral infections associated with cardiovascular disease should be paid attention to and should be mentioned in the CT report.

Incidental thyroid nodules are considered common findings in the cross-sectional imaging of the neck, constituting about 16 to 18% (23). In our study, the second most common clinically significant NCF was thyroid nodule. A thyroid nodule incidentally during CT examination is a critical finding because, although the incidence of malignancy is not high, it has been reported that early diagnosis of thyroid malignancy can have a great impact on patient outcomes (24). Most adrenal adenomas are non-functional and are detected incidentally on routine imaging performed for unrelated reasons (Figure 5a, 5b). An adenoma is the most common adrenal tumor in patients with or without a history of extra-adrenal malignancy. The present study detected adrenal adenoma in 145 (2.17%) patients. The prevalence of adrenal adenoma is related to age and has been reported to be 7% above 70 years of age. CT does not allow distinguishing functional and non-functional adenomas from each other (25). Functioning adenomas are associated with excessive cortisol secretion and its deleterious effects, hypertension, type 2 diabetes mellitus, and an increased risk of osteoporotic fractures. On the other hand, primary adrenal cancer is associated with significantly higher mortality and morbidity and requires urgent treatment (26,27). In our study, adrenal non-adenomatous mass was detected in 3 patients. Evaluation of both adrenal adenoma and adrenal mass in terms of medical or surgical treatment are significant findings that require communication with the clinician in order.

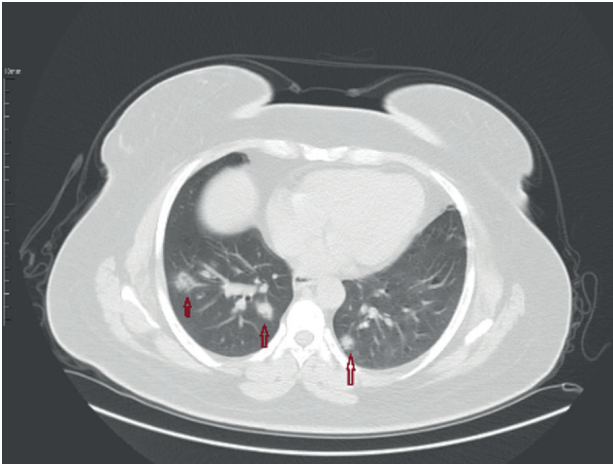


Figure 5a: 42-year-old male patient; focal consolidation in both lower lobes in the lung parenchyma window in Figure 5a (red arrows)

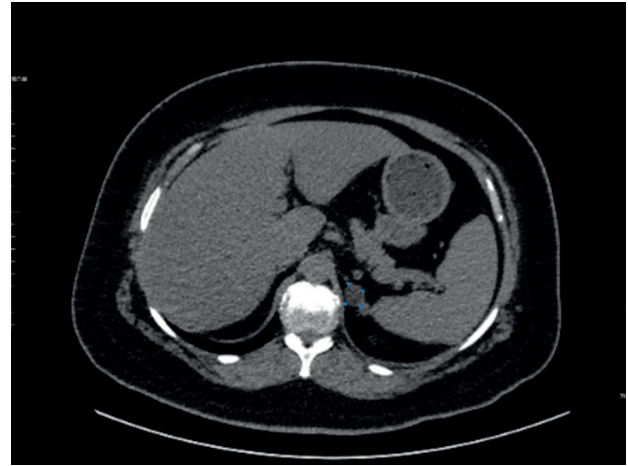


Figure 5b: A low-density, well-circumscribed lesion compatible with an adenoma in the body of the left adrenal gland in the mediastinal window in Figure 5b (blue dots).

Limitations

This study is that the detailed clinical histories were not questioned since all patients were initially investigated with the suspicion COVID-19 pneumonia. Therefore, the radiologist did not know exactly whether the pathologies were known when reporting.

CONCLUSION

CT examinations performed in patients with suspected COVID-19 pneumonia should be examined in detail regarding clinically significant findings. In addition, early

detection of clinically insignificant incidental findings is also crucial. Although most of the findings detected incidentally in imaging performed for unrelated reasons are insignificant, it is vital to take necessary precautions in advance regarding pathologies that may be clinically significant regarding appropriate treatment and follow-up planning at the appropriate time. It is crucial that the clues are stated in the radiology report so that the clinician can make appropriate management regarding these pathologies.

Conflict of Interest: No conflict of interest was declared by the authors.

Ethics: This retrospective study was approved by Ethics Committee of İstanbul Haseki Training and Research Hospital, İstanbul. (Date: 19.08.2020; Number: 2020-132).

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