ORIGINAL ARTICLE

Variation of Chest Computed Tomographic Findings in Coronavirus Disease-19 (COVID-19) Positive Patients in a Tertiary Care Hospital, Bangladesh

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ABSTRACT

Background: We aimed to report different patterns of chest computed tomographic (CT) findings in coronavirus disease-19 (COVID-19) infected patients in Bangladesh.

Methods: This was a cross-sectional descriptive study of 200 consecutive reverse transcriptase polymerase chain reaction (RT-PCR) positive patients who underwent CT chest. Distribution, type of abnormal lung findings and Prevalence were recorded.

Result: Among the total study cohort of 200 patients, 148(74 %) were males and 52 (26 %) were females with mean age of 53.9 ± 16.7 years (range 20–92 years). We observed lung parenchymal abnormalities in 125 (62.0 %) cases whereas 75 (37.5 %) RT-PCR positive cases had a normal chest CT. Common symptom was cough in 108 (54%), Only 18.0% of the patients were dyspneic. Among the patients with abnormal CT findings bilateral involvement was commonest 98/125 (78.4 %), multilobar (54.0 %) lung involvement with a predominant peripheral and posterior distribution was more commonly observed. With regards to the type of opacity, ground glass opacity (GGO) was the predominant abnormality found in 122/125 cases. Pure GGO was observed in 29 (23.2 %), most common pattern was GGO mixed with consolidation was noted in 52(41.6 %). GGO with crazy paving pattern was seen in 33 (26.4 %) and sub pleural linear and curvilinear lines were seen in 23(18.4%). Peri-lesional or intralesional segmental or subsegmental pulmonary vessel enlargement was observed in 36 (70.6 %) cases

Conclusion: In this study population, we found a high proportion of symptomatic laboratory-confirmed SARS-CoV-2 patients had positive chest CT findings. Patients with a positive CT showed typical findings of predominant GGOs in a bilateral and multilobar distribution with peripheral predilection.

Key words: chest computed tomographic (CT), coronavirus disease-19 (COVID-19), reverse transcriptase polymerase chain reaction (RT-PCR)

Introduction

First case of pneumonia with unknown cause were reported to the World Health Organization (WHO) on 31st December 2019 from Wuhan city. By 7th January, 2020, a novel coronavirus was identified for this and termed '2019-nCoV'. Subsequently, the virus was officially named as Severe Acute Respiratory Syndrome coronavirus 2 (SARS CoV-2) and the illness caused is termed COVID-19 (Corona Virus Disease 2019) by the WHO. On 30th January, COVID-19 was declared as a public health emergency of international concern and by 11th March, 2020 declared it as a global pandemic[1 2] Since then COVID-19 claiming many lives. According to WHO Coronavirus Disease (COVID-19) Dashboard by 7th January 2021, there have been 87619505

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confirmed of COVID-19, including 1889556 deaths. The first confirmed cases of COVID-19 Bangladesh were reported on 8 March, 2020[3]. In Bangladesh more than 518898 cases has detected with death troll 7687. These numbers are likely to further increase here as travel and lock-down restrictions are eased. The incubation period of the disease is generally 3-7 days, but no longer than 14 days.[4] Clinical presentations of COVID-19 ranges from asymptomatic, mild symptom to severe illness. This disease mainly affects the lower respiratory tract infection. Isolation of virus in the respiratory samples using real-time reverse transcriptase-polymerase chain reaction (RT-PCR) is the testing of choice for detection of COVID-19. RTPCR has variable sensitivity ranging from 37% to 91%[5-6] Initially RT-PCR test result can be false negative and may require repeat test. Furthermore in low resources country RE-PCT test not easily available and there may be significant delay in getting test result. Chest Imaging findings of COVID-19 resemble to other viral pneumonias. So Computed Tomography (CT) can be useful in detecting and management of the patients with suspected of positive COVID-19 patients.

CT findings mainly include ground glass opacities (GGO) with a peripheral and basal predominance as the initial manifestation of the disease. GGOs are gradually transformed into consolidations during the intermediate stage of the disease. After 9–13 days of onset of symptoms the CT findings become peak. Along with clinical recovery the pulmonary opacities show a gradual resorption with development of sub pleural lines, reticulations, fibrous stripes and perilobular opacities. In some patients the clinical course is complicated by acute respiratory distress syndrome (ARDS) or pulmonary embolism, the main causes of death [7]. Ground glass opacity (GOO) is defined as an area of increased attenuation in the lung on CT scan with preserved underlying bronchial and vascular markings.[8] In this study we analyzed the different pattern of HRCT findings of COVID-19 patients.

Materials and methods:

This was a cross-sectional study was done from April 2020 to July 2020, conducted in Bangabondhu Sheikh Mujib Medical University and Ibrahim Cardiac Hospital and Research Institute, Dhaka Bangladesh. Bangabondhu Sheikh Mujib Medical University is a designated COVID-19 care center with separate fever clinic, inpatient, intensive care unit (ICU) and quarantine facilities. Institutional Ethical Committee (IEC) has taken. This study includes 200 consecutive symptomatic RT-PCR positive patients who were referred to radiology and imaging department for High Resolution Computed Tomography (HRCT). RT-PCR positive patients with symptoms like fever cough fatigue, soar throat or dyspnea was included in this study. Asymptomatic RT-PCR positive patients are excluded from this study. Patients with severe illness, defined by the WHO interim guidelines for clinical management of COVID-19 as [a] respiratory rate $\geq$ 30 breaths/min, or [b] oxygen saturation (SpO2) $\leq$ 90 %, or [c] respiratory failure needing mechanical ventilation, or [d] ARDS, or [e] shock were admitted to intensive care unit (ICU).[9] Symptomatic patients with no signs of respiratory failure were admitted in routine ward. Asymptomatic patients were observed in the quarantine and chest CT was not done. HRCT was performed by two CT scanner. One is a 160 slice multi-detector CT unit (Toshiba Japan) with the following parameters: tube voltage 100–120 kVp, tube current 90–130 mA s, collimation of 16 × 0.6 and a pitch of 1.5. Another is GE-Revolution Evo 128 Slice multidetector CT scanner with the following parameters: tube voltage 100–120 kVp, tube current 200-250 mAs, collimation of 16 × 0.6 and a pitch of 0.98. The CT images were acquired in a inspiratory breath-hold phase. Images were reconstructed of 0.7 mm into 1 mm thick slices. The images were viewed in both lung window settings (width 1200–1500 HU; centering -500 to -600HU) and mediastinal window (width 300−400HU; centering 40HU). The CT suite was disinfected by using 70 % ethanol or 0.1 % sodium hypochlorite. After each CT examination, passive air exchange was allowed for 30 min. HRCT was reviewed by group of radiologist in a ADW workstation and Vitrea workstation and gave final report. The radiologists are assessed the presence or absence of pulmonary opacities, location, type of opacities and the extent of opacities. The location of one lung (right, left) or both the lungs. The number of lobes involved was determined. Distribution of the opacities was described as central (defined as the inner two-third of the lung tissue) and peripheral (defined as outer one-third of the lung). Lung lesions were devided using Fleischner society glossary of terms for thoracic imaging [10] GGO (ground glass opacity) was defined as an increase in the density of lung with non-obscuration of bronchial and vascular structures, whereas consolidation was defined as increased density of lung tissue through which vascular and bronchial structures were not visible. Furthermore, the readers also evaluated presence of associated airway, vascular, pleural and mediastinal abnormalities. A semi-quantitative scoring system was used to quantitatively estimate the pulmonary involvement by visually calculating the percentage of the total lung involvement by dividing each lung into 3 zones, followed by averaging the 6 zones to obtain the percentage of the total lung involvement [11]. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSSInc). Continuous variables were expressed as mean, ranges and standard deviation, whereas categorical variables were expressed as counts and percentages.

Results:

Among the total study population of 200 patients, 148 (74 %) were males and 52(26 %) were females with mean age of 53.9±16.7 years (range 20–92 years). Fever was the commonest symptom seen in 145 (72.5 %) followed by malaise in 132 (66.0 %), cough in 108(54 %) and anosmia in 44 (22.0%). Dyspnea found in 36 (18.0 %). Only 13 (6.5 %) of the patients had chest pain (Table I). Lung parenchymal abnormalities were observed in 125 (62.0 %) cases, and normal HRCT in 75 (37.5 %) of RT-PCR positive cases. Among the patients with abnormal CT findings, bilateral lung involvement was the commonest, observed in 98/125 (78.4 %) unilateral involvement in 27 (21.6%). Multiple lobe involvement was seen more frequently. 68 (54.0 %) had involvement of all the 5 lobes whereas four lobes involvement was seen in 19(15.2%), three loves in 11(8.0%), two lobes in 10 (8.0%) and single lobe involvement was seen in 17 (13.6 %) (Table II).

In terms of distribution, peripheral distribution was the commonest, seen in 84/125 (67.2 %) cases followed by peripheral and central lesions in 28/125(22.4%). Only 13/125(10.4%) patients had only central distribution.

Table I: Distribution of patients by their clinical symptoms (n=200)

Clinical Symptoms	Frequency	Percentage
Fever	145	72.5
Cough	108	54.0
Dyspnea	36	18.0
Malaise	132	66.0
Anosmia	44	22.0
Chest pain	13	6.5
Chest pain and cough	8	4.0

Table II. Distribution of patients by their CT findings (n=200)

Distribution of CT findings	Frequency	Percentage
Lung parenchymal involvement present	125	62.0
Lung parenchymal involvement Absent	75	37.5
Bilateral Involvement	98	78.4
Unilateral involvement	27	21.6
Number of lobe involvement	--	--
5 lobes	68	54.0
4 lobes	19	15.2
3 lobes	11	8.0
2 lobes	10	8.0
1 lobe	17	13.6

Considering the type of opacity, GGO was the dominant abnormality, found in 122/125 cases. Pure GGO was observed in 29 (23.2%), (Fig -1). Most common pattern was GGO with consolidation in 52 (41.6%), GOO with crazy paving that is interlobular septal thickening and intralobular lines pattern in 33 (26.4%) (Fig - 3). (Table III).

Small number 8 (6.4%) of patients showed GOO with air bronchogram. Only 3 (2.4%) patients show pure consolidation (Fig-3). Sub pleural linear and curvilinear lines were seen in 23 (18.4 %) (Fig - 4). Only 5 (4.0%) of patients showed reverse halo sign (Fig - 5).

Table III. Distribution of patients by their CT findings of lung parenchymal involvement (n=125)

CT findings of lung parenchymal involvement	Frequency	Percentage
Peripheral lesion	84	67.2
Central lesion	13	10.4
Peripheral and central lesions	28	22.4
Pure GOO	29	23.2
Pure consolidation	3	2.4
GOO and consolidation	52	41.6
GOO and crazy paving	33	26.4
GOO and airbronchogram	8	6.4
Perilesional and Intralesional vessel enlargement	88	70.6
Sub pleural linear and curvilinear lines	23	18.4
Helo sign	5	4.0
Bronchial dilatation	4	8.8
Pleural effusion	16	12.8
Mediastinal lymphadenopathy	11	8.8

Bronchial dilatation was observed in 4(8.8%). Perilesional or intralesional segmental or subsegmental vessel enlargement was observed in 88 (70.6 %) of cases. Few severely ill patients with cardiac problem shows pleural effusion 16(12.8%). Mediastinal lymphadenopathy was found in 11(8.8) patients. (Table III).

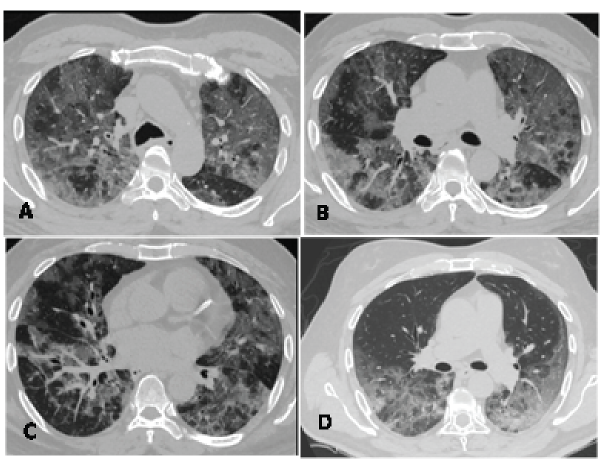

Figure 1 (A,B,C and D): Non-contrast axial chest CT images in the lung window setting of a 50-year old male and 68-year female COVID-19 positive patient, obtained 7 days after symptom onset, at the carinal (a), subcarinal (b,d), mid-basal (c) levels showing bilateral , confluent ground glass opacities with pronounced peripheral distribution with perilesional vessel enlargement (c,d).

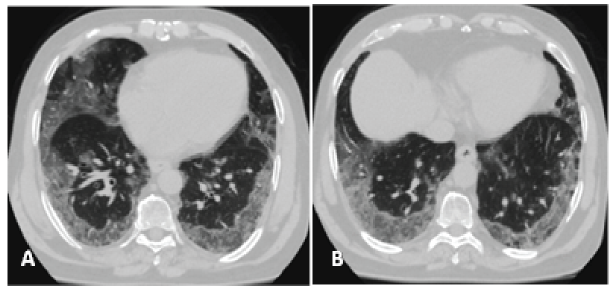

Figure 2 (A and B): Non-contrast axial chest CT images (A,B) in the lung window setting of a 62-year old male COVID-19 positive patient, obtained 9 days after symptom onset, showing bilateral diffuse confluent ground glass opacities with pronounced peripheral and posterior distribution with interlobular septal thickening producing crazy-paving pattern.

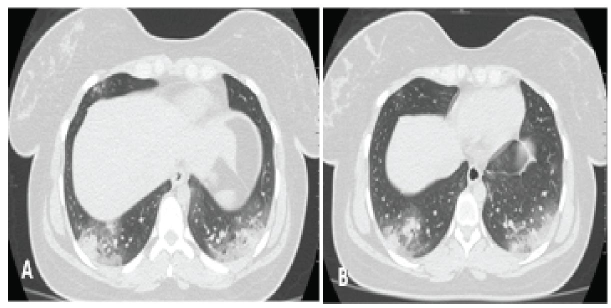

Figure 3(A and B): Non-contrast axial chest CT images (A,B) in lung window settings of a 28-year old female COVID-19 positive patient, obtained 8 days after symptom onset, showing multiple patchy peripheral predominantly posterior ground glass opacities with progression to consolidation in both lungs.

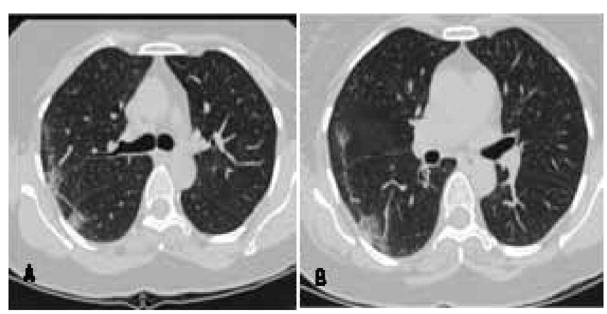

Figure 4 (A and B): Non-contrast chest CT axial image (A,B) in a 55-year old male COVID-19 positive patient, obtained 10 days after symptom onset, showing sub-pleural curvilinear lines with few reticulations in right lower lobe and associated mixed GGO-consolidation pattern.

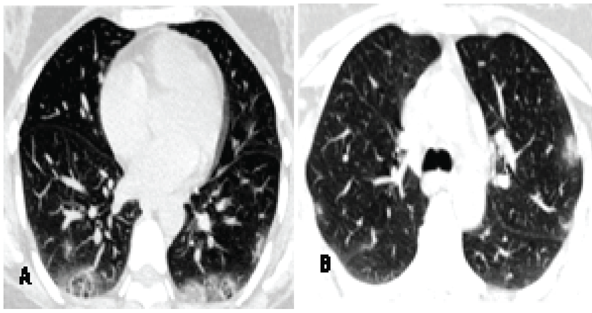

Figure 5 (A and B): Non-contrast chest CT axial image (a) in a 42-year old female COVID-19 positive patient, obtained 7 days after symptom onset, showing multiple patchy peripheral ground glass opacities with progression to consolidation in both lungs. There is also evidence of reverse hallo or atoll sign in posterior sub pleural location of both lung.

Discussion:

We recorded a positive CT in a high proportion (96/147; 65.3 %) of patients with RT-PCR confirmed SARS-CoV-2. This data is in near similar to the studies from China, Korea and Europe which have reported lung parenchymal abnormalities in 61%–100% RT-PCR positive patients.[12-14]

Caruso D et.al[13] reported pulmonary findings in 96.6 % of symptomatic cases on CT. Fever (61 %) were the commonest symptom in their cohort followed by cough (56 %) and dyspnea (33 %).[15] Our study positive pulmonary findings on CT was 62% . fever 72.5% was the commonest symptoms followed by cough 56% and dyspnea 18%.

In an environmentally homogenous cohort (Diamond Princess Cruise ship), Inui S et.al (14) reported a normal chest CT in 21 % of symptomatic COVID-19 cases.[16] We also reported 37.5% normal chest findings of symptomatic COVID-19 cases. Ai T et.al [15] reported CT findings in 888 (88.7%) among the total study population of 1014 COVID-19 patients. They further observed that 3% RT-PCR positive cases with clinical symptoms had a normal CT scan.[17] In our study among the patients with lung parenchymal abnormalities on CT, bilateral lung involvement with multilobar distribution and a peripheral predilection was commonly observed. This finding fairly similar the distribution and type of pulmonary opacities reported in COVID-19 pneumonia. GGO was the dominant abnormality, found in all 122/125 (%) cases. Pure GGO was observed in 29 (23.2%), GGO with consolidation in -52 (41.6%) and GOO with crazy paving that is interlobular septal thickening and intralobular lines pattern in 33 (26.4%). A Systematic review done by Salehi et al[18] from various countries wherein they found that GGO was present in 88 % cases across 22 studies reported. Our findings are also in similar with this study.

Segmental or subsegmental intra-lesional or peri-lesional pulmonary vessel enlargement was observed in 70.6 % patients. Our findings are in concordance with Yan Li et al.[14] who reported vascular enlargement in 82.4 %. The various putative etiologies that have been put forth to account for this unique finding of vascular enlargement include, vasodilatation induced by the release of proinflammatory cytokines, small vessel pulmonary embolism and infection induced pulmonary vasculitis.[19] Pulmonary vascular enlargement is an important sign/findings in COVID-19 pneumonia diagnosis as it has not been reported previously in any infectious disease settings. Bai et al.[20] reported vascular enlargement to be frequently associated with COVID-19 pneumonia compared to non−COVID-19 pneumonia with a significant p-value (< 0.001). So enlarged vessel is an important diagnostic criteria to discriminate COVID-19 pneumonia from non−COVID-19 pneumonia. CT is not recommended for screening of COVID-19. However, in our understanding CT has a significant contribution to the clinical management of the COVID-19 pneumonia patients. According to the German Radiological Society, CT may aid in assessing the initial extent of the lung involvement, help in recognition of the complications and also help in monitoring the progression of the disease.[21] J. According to American College of Radiology (ACR) guidelines, CT should be reserved for hospitalized, symptomatic patients with specific clinical indications like worsening respiratory status.[22]

There are several limitations to our study. First, we include both in-patient and outpatient focused on initial CT findings and did not perform follow-up CT examinations. So disease progression could not be assessed. This may result in non-inclusion of symptomatic cases that may have developed lung changes late in the course of disease and hence a spurious high rate of negative CT in the study population. Second, imaging was performed in all symptomatic cases regardless of the severity of illness.

Conclusion:

In conclusion, we found a high proportion (62%) of positive chest CT in symptomatic laboratory-confirmed SARS-CoV-2 patients. Patients with a positive CT showed the same CT features as reported in other series with a predominance of GGOs in a bilateral and multilobar distribution with peripheral predilection.

Conflict of interest: None.

Reference:

1. World Health Organization (WHO) Timeline-COVID -19 2020 [Available from: https://www.who.int/news-room/detail/27-04-2020-who-timeline—covid-19 accessed 12 May 2020.
2. Cennimo DJ, Bergman SJ. Coronavirus Disease 2019 (COVID-19). In: https://emedicine. medscape.com/article/2500114-overview-a1,ed. Medscape, 2020.
3. Hossain I, Khan MH, Rahman MS, Mullick AR, Aktaruzzaman MM. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in Bangladesh: A descriptive study. Journal of Medical Science and Clinical Research. 2020;8(04)
4. Chen Y, Liu Q, Guo D. Emerging coronaviruses: genome structure, replication, and pathogenesis. Journal of medical virology. 2020 Apr;92(4):418- 23.
5. Ai T, Yang Z, Hou H, et al. Correlation of Chest CT and RTPCR Testing in Coronavirus Disease 2019 (COVID-19) in China: A Report of 1014 Cases. Radiology 2020:200642. doi: 10.1148/radiol.2020200642.
6. Liu R, Han H, Liu F, et al. Positive rate of RT-PCR detection of SARS-CoV-2 infection in 4880 cases from one hospital in Wuhan, China, from Jan to Feb 2020. Clin Chim Acta 2020;505:172-75.doi: 10.1016/j.cca.2020.03.009.
7. A.H. Parry, A. H. Wani. Pulmonary Embolism in corona virus disease-19 (COVID-19) and use of compression ultrasonography in its optimal management, Thromb. Res. (May) (2020).
8. Dr. Daniel J Bell, Dr. Behrang Amini et al. Ground-glass opacification. Radiopardia.org.
9. World Health Organization, Clinical Management of Severe Acute Reaspiratory Infection When Novel Corona virus (NCoV) Infection Is Suspected: Interim Guidance, (2020) https://www.who.int/publications-detail/clinical-management-of severe-acute respiratory- infection-when-novel-conoronavirus- (ncov)- infection -is suspected. Published on January 12, 2020. Updated on March 13, 2020.Accessed on March 20, 2020.
10. D. M. Hansell, A. A. Bankier, H. MacMahon, T. C. Mcloud, N. L. Muller, Remy J. Fleischner Society, Glossary of terms, for thoracic inmaging, Radiology 246 (March 3) (2008) 697-722.
11. S. M. Tabatabaei, H. Talari, F. Moghaddas, H. Rajebi, Computed Tomographic features and short-term prognosis of coronavirus disease 2019 (COVID-19) pneumonia: a single-center study from Kashan, Iran, Radiology2 (April (2)) (2020) e200110.
12. Z. Ye, Y. Zhang, Y. Wang, et al., Chest CT manifestations of new coronavirus disease 2019 (COVID-19): a pictorial review, Eur. Radiol. 2020; https://doi.org/10.1007/ s00330-020-06801-0.
13. Li, K., Fang, Y., Li, W. et al. CT image visual quantitative evaluation and clinical classification of coronavirus disease (COVID-19). Eur Radiol 2020; 30: 4407–4416. https://doi.org/10.1007/s00330 -020-06817-6.
14. Y. Li, L. Xia, Coronavirus Disease 2019 (COVID-19): role of chest CT in diagnosis and management, American Journal of Roentgenology. 2020;214: 1280-1286. 10.2214/AJR.20.22954. https://www.ajronline.org/doi/full/10.2214/AJR.20.22954
15. D. Caruso, M. Zerunian, M. Polici, F. Pucciarelli, T. Polidori, C. Rucci, G. Guido, B. Bracci, C. de Dominicis, A. Laghi, Chest CT features of COVID-19 in Rome, Italy, Radiology (April) (2020) 201237.
16. S. Inui, A. Fujikawa, M. Jitsu, N. Kunishima, S. Watanabe, Y. Suzuki, S. Umeda, Y. Uwabe, Chest CT findings in cases from the cruise ship “Diamond Princess” with coronavirus disease 2019 (COVID-19), Radiology 2 (March (2)) (2020) e200110)

17. T. Ai, Z. Yang, H. Hou, C. Zhan, C. Chen, W. Lv, Q. Tao, Z. Sun, L. Xia, Correlation of chest CT and RT-PCR testing in coronavirus disease 2019 (COVID-19) in China: a report of 1014 cases, Radiology. February, 2020; 296(2): 200642. https://doi.org/10.1148/radiol.2020200642

18. S. Salehi, A. Abedi, S. Balakrishnan, A. Gholamrezanezhad, Coronavirus disease 2019 (COVID-19): a systematic review of imaging findings in 919 patients, Am. J. Roentgenol. March, 2020; Jul;215(1):87-93.

19. A. H. Parry, A. H. Wani, Segmental pulmonary vascular changes in COVID-19 pneumonia, Am. J. Roentgenol. (May) (2020) W1-.

20. H.X. Bai, B. Hsieh, Z. Xiong, K. Halsey, J.W. Choi, T.M. Tran, I. Pan, L.B. Shi, D.C. Wang, J. Mei, X.L. Jiang, Performance of radiologists in differentiating COVID19 from viral pneumonia on chest CT, Radiology. March, 2020; 296(2) :200823. https://doi.org/10.1148/radiol.2020200823

21. J. Vogel-Claussen, J. Ley-Zaporozhan, P. Agarwal, J. Biederer, H.U. Kauczor, S. Ley, H. Kühl, U.G. Mueller-Lisse, T. Persigehl, C.L. Schlett, D. Wormanns, Recommendations of the Thoracic Imaging Section of the German Radiological Society for Clinical Application of Chest Imaging and Structured CT Reporting in the COVID-19 Pandemic, In RöFo-Fortschritte auf dem Gebiet der Röntgenstrahlen und der bildgebenden Verfahren, © Georg Thieme Verlag KG, 2020 May 26.

22. ACR COVID-19 Clinical Resources for Radiologists. Available at: https://www.acr.org/Clinical-Resources/COVID-19-Radiology-Resources