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Original Research Article

Sensitivity of Portable Chest X-ray and CT for COVID-19 Patients (in Low-Resource Settings)

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Abstract

The aim of this research was to evaluate the capabilities of chest x-ray and Computed Tomography (CT) equipment in the diagnosis and monitoring of changes in the lungs in patients diagnosed with COVID-19 by reverse transcriptase-polymerase chain reaction (RT-PCR). In this study we analyzed radiological investigation (chest x-ray and CT) results of 50 RT-PCR positive COVID-19 patients, treated in Azerbaijan Medical University clinic between 01 April 2020 and 20 April 2020. Chest x-ray was performed according to standard protocols in digital mode by mobile x-ray unit. CT was performed according to standard local protocols in native mode, images were acquired by 1 mm slices both in lung and soft tissue windows. Sensitivity of both radiological methods was calculated compared to RT-PCR results. The most common finding in chest X-ray were ground-glass opacities (64%) and consolidation (24%). Sensitivity of chest x-ray for COVID-19 infection was 88% (44/50, 95% CI 75.7% - 95.5%). The most common finding in chest CT also were ground-glass opacities (72%) and consolidation (24%). Sensitivity of chest CT for COVID-19 infection was 96% (48/50, 95% CI 86.3% to 99.5%). Despite the lower sensitivity of portable x-ray examination (88%) in comparison with CT (96%), it is recommended to be performed in each patient and is suitable for use in dynamic observations, particularly considering it's accessibility, transportability and ease of use.

Keywords: COVID-19, portable X-ray, pneumonia, chest CT, chest x-ray

INTRODUCTION

New type coronavirus associated with severe acute respiratory syndrome (SARS), which initially was registered in Wuhan in December 2019, now became a global problem. Taking into account the severity and propagation speed of the disease, early diagnosis is essential for effective treatment as well as to prevent further dissemination (Xie et al., 2020).

Today the RT-PCR is widely used for COVID-19 diagnosis. In spite of the fact that RT-PCR is considered as an etalon standard method, in some cases false negative results at the beginning of the disease could be one of the major limitations in early diagnosis of COVID-19. In a study by Xie X. et al. they compared results of 167 COVID-19 patients and found that 3% (n = 5) patients had negative RT-PCR test CT signs of typical COVID-19 pneumonia (Geoffrey et al., 2020). Of course, in general the radiological signs observed in COVID-19 pneumonia are also observed in other viral pneumonias. However, the fact that these symptoms are synchronous with the pandemic, COVID-19-specific clinical symptoms and appropriate testing provides a basis for evaluating the process in favor of COVID-19 pneumonia.

Although there are different approaches to the application of visualisation methods, the recommendations developed by the Fleischner Society, an international, multidisciplinary society of thoracic radiology on April 1, 2020, based on the data provided by 9 of the 15 countries where the pandemic is most prevalent, are very relevant (Ming-Yen et al., 2020). For this reason, the results of chest x-ray and CT play an

essential role in the diagnosis of COVID-19 pneumonia and are important for both radiologists and clinicians.

The aim of this research was to evaluate the capabilities of chest x-ray and computed tomography (CT) examinations in the diagnosis and monitoring of changes in the lungs in patients diagnosed with COVID-19 by RT- PCR.

MATERIAL AND METHODS

In this retrospective study which was undertaken from 01 April 2020 to 20 April 2020, we analyzed results of radiological investigation (chest x-ray and CT) results of 50RT-PCR positive COVID-19 patients, treated in clinic of Azerbaijan Medical University Clinic (ethical approval was obtained from the Ethics Committee of the University). The mean and median ages of patients included in the study were 51,4 and 53 (19-82) respectively. Fourteen of the patients (28%) were males and 36 (72%) were females.

Chest x-ray was performed according to standard protocols in digital mode as described in the literature (Adejoh et al., 2020). The x-ray machine was a mobile x-ray unit Arcovis 3000 manufactured by Villa Medical System. Images were taken in posterior-anterior (PA) projection for 36 patients and anterior-posterior (AP) projection for 14 patients who could not sit up. The frequency and localisation of ground glass opacity (GGO), consolidation and pulmonary nodules were assessed considering that they are the most common findings in previously published studies (Ming-Yen et al., 2020; Song et al., 2020; Jeffrey et al., 2020). The main localisations were defined as perihilar predominance, bilateral lung involvement, upper, middle and lower lung zones.

CT scanner was Aquilon Vision128 with 120 kVp tube from Toshiba Medical Systems. Scanning was performed according to standard local protocols in native mode, images were acquired by 1 mm slices both in lung and soft tissue windows.Changes in CT examination were characterized by the presence, localization and density.

The results of the examinations were also compared in terms of course of the disease (disease progression and stabilization).

Statistical analysis was performed with IBM SPSS Statistics software (Build 1.0.0.1347; IBM, New York, USA). McNemar Chi-squared test was applied to evaluate the sensitivity of chest X-ray and CT compared to RT-PCR results. Statistical significance was defined as $p < 0.05$.

RESULTS AND DISCUSSION

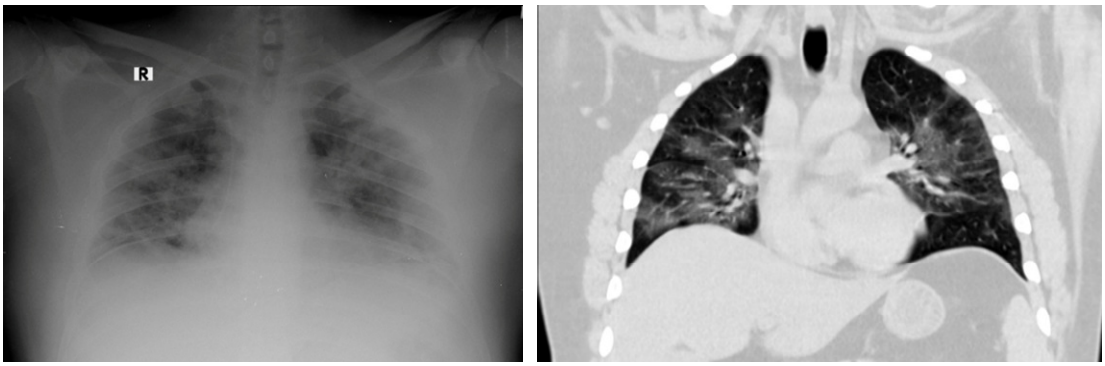
Although chest x-ray is less informative than CT, it is considered as the first line method in the diagnosis of COVID-19 pneumonia. The mobility and possibility of easy disinfection makes its use even more convenient (ACR Recommendations for the Use of Chest Radiography and Computed Tomography (CT) for suspected COVID-19 Infection, 2020).

The most common clinical signs were respiratory symptoms (81%) and the fever (42%). Arterial hypertension (21%) and diabetes mellitus (13%) were the most common comorbidities. The most common finding in chest x-ray was GGO which was found in 32 (64%) cases. The second most common sign was consolidation, which was observed in 12(24%) patients (Figure 1). In 6 (12%) patients no changes were revealed on chest X-ray. Above mentioned changes were mainly located in the peripheral zone (62% cases), lower lung zone (70% cases) and bilateral lung tissues (56% cases). In one case (2%) pleural effusion was defined.

The most common symptom on CT was also GGO, which was found in 36 (72%) patients (Figure 1). In addition, areas of consolidation were found in 12 (24%) patients, which were visualized in the images along with GGO (Figure 1). Among other typical symptoms, pleural fibrotic bands were found in 18 (36%) patients, nodules in 9 (18%) patients, crazy-paving pattern in 9 (18%) patients, and vascular dilatation in 6 (12%) patients. Pleural effusion was detected in 1 patient. No changes were detected in CT examination in 2 (4%) patients. The lesions were mostly observed in the peripheral lung areas (70%) and in the lower posterior segments (76%) and in 60% were bilateral. A summary of chest X-ray and CT symptoms observed in patients is given in the table 1.

With the aim of follow-up chest x-ray was performed repeatedly in 5 patients and CT in 3 patients. In 2 patients examined repeatedly by x-ray, an increase in areas of consolidation and GGO in the lungs were observed within 3 days. Positive dynamics was observed on X-ray in 2 patients during 3 days, and in 1 patient the picture remained stable for 7 days.Followup CT scans were performed in 4 days after the first CT was taken. Weakening in the intensity and volume of consolidation was observed in 2 patients. In the third patient, CT examination revealed an increase in GGO and consolidation areas multifocally.

Other studies in this area have shown that specific changes in the radiograph are detected in 69% of patients upon admission to the hospital and in 80% later during disease course, and these changes were more visible on days 10-12 (Jeffrey et al., 2020; Wang et al., 2020). In our study, more significant changes on chest X-ray also were found within the same time schedule. Thus, on days 4 to 8 since manifestation of clinical symptoms, mainly unilateral GGO, on days 8-12 GGO and consolidations and in one case left pleural effusion were detected. The changes were mostly located in the right lung – 29 (58%) cases, lower lung zones – 35 (70%), were peripheral - 31 (62%) cases and had mixed



A B

Figure 1. Chest X-ray (A) and CT (B) images of COVİD-19 pneumonia. Ground-glass opacities in peripheral lung zones and in perihilar regions and focal consolidation in lower lobe of the right lung with surrounded GGO zone. Vascular dilatation is seen in both lower lobes.

Table 1. Summury of chest x-ray and CT findings

Signs		Chest x-ray	CT
		n (%)	n (%)
Solidity			
	Ground-glass opacity	32 (64%)	36 (72%)
	Consolidation	12(24%)	12 (24%)
Side			
	Right lung	29 (58%)	32 (64%)
	Left lung	15 (30%)	16 (32%)
Lung zones			
	Upper lung zone	1(2%)	2 (4%)
	Middle lung zone	8 (16%)	8 (16%)
	Lower lung zone	35 (70%)	38 (76%)
Location			
	Central	4(8%)	3 (6%)
	Peripheral	31 (62%)	35 (70%)
	Central and peripheral	9 (18%)	10 (20%)
Structure			
	Mixed	36 (72%)	40 (80%)
	Nodular	5 (10%)	5 (10%)
	Linear	3 (6%)	3(6%)
No changes		6 (12%)	2(4%)

structure – 36 (72%) cases.

In two cases on chest X-ray false positive results were reported. Both patients were females for whom portable x-ray investigation was performed. Due to the summation shadows of the mammary glands, the areas seen on the radiograph as GGO were not confirmed by CT examination. The sensitivity of chest X-ray for COVID-19 infection was 88% (44/50, 95% CI 75.7% - 95.5%).

CT being the leading method in the diagnosis of COVID19 pneumonia allows early detection as well as the monitoring of the disease course (Jeffrey et al., 2020; ACR Recommendations for the Use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection, 2020; Wang et al., 2020). The main CT findings are GGO with or without consolidation, mostly in lower lung zones (Wang et al., 2020; Chung et al., 2020). Also crazy-paving and halo signs could be observed (Fang et al., 2020; Qian et al., 2020; Bernheim et al., 2020; Kunhua et al., 2020). In our study, GGO was found in 36 (72%) patients.

Consolidation is another typical CT sign for COVID-19 pneumonia which is usually multifocal, mixed or segmental and occurs in 2–64% (Xu et al., 2020; Song et al., 2020; Zheng et al., 2019). In our study, consolidations on CT were found in 12 (24%) patients.

Reticular patterns manifested by thickening of the interlobular septa and interstitial structures were seen in the form of numerous linear shadows on CT images and were detected in 3 (6%) patients.

The appearance of crazy-paving sign on CT is charac-

terized by thickening of the interlobular septa and intralobular lines on the background of the GGO and is not as common as the GGO and consolidations (Pan et al., 2020). This condition, as in other SARS viruses, is caused by alveolar edema and interstitial inflammation in acute lung tissue impairment and occurs in 5-36% of CT scans (Wong et al., 2003; Kunhua et al., 2020). In our study, a crazy-paving pattern was found in 8 (16%) cases. Observation of this sign togeher with diffuse GGO and consolidations indicates the peak period of the disease (Zheng et al., 2019).

In CT scans of 14 (28%) patients pleural bands were observed in the form of thin curved lines of 1-3 mm thickness and parallel to the pleura. Researchers found this symptom in 20% of COVID-19 patients and associated it with pulmonary edema and fibrosis (Hansell et al., 2008).

In 6 (12%) cases intrapulmonary vascular dilatation was detected which is thought to be caused by damage to the capillary walls by inflammatory factors (Zheng et al., 2019). Nodules appearing as circular indistinct shadows less than 3 cm in diameter are common in viral pneumonias, their incidence of COVID-19 is 3-13% and often associated with the halo sign (Franquet, 2011). Among our patients, the incidence of nodules was 10% (5 patients).

In our study, changes in CT examination were mainly localized in the right lung - 32 (64%), in the lower-posterior zones - 38 (76%), were peripheral - 35 (70%) and mixed structure - 40 (80%). Other signs like air bubbles, halo and reverse halo signs, lymphadenopathy or cavitation, which were less typical for COVID-19 pneumonia on CT scan were not detected.The sensitivity of CT for COVID-19 infection was 96% (48/50, 95% CI 86.3% to 99.5%).

CONCLUSION

Radiological examinations are of high informative value in the diagnosis and management of COVID-19 pneumonia. The main criterion for Covid-19 pneumonia is the appearance of bilateral peripheral focal or multifocal GGO, which is detected at a higher frequency. Despite the substantial although lower sensitivity of portable x-ray examination (88%) in comparison with CT (96%), it is recommended to be performed in each patient and is suitable for use in dynamic observations, particularly taking into account its accessibility, transportability and ease of use.

Implications for practice

Consideration of the study results could improve the diagnosis of COVID-19 pneumonia in low resource settings.

REFERENCES

ACR Recommendations for the Use of Chest Radiography and Computed Tomography (CT) for Suspected COVID-19 Infection (2020). American College of Radiology, 11 Mar. ACR [accessed 16 March 2020]

Adejoh T, Elugwu CH, Ezugwu EE, Sidi M, Aronu ME (2020). A single-centre experience of radiation dose mitigation in computed radiography using dose charts. Pakistan J. Radiol. 30(1): 25 – 33

Bernheim A, Mei X, Huang M et al (2020). Chest CT findings in coronavirus disease-19 (COVID-19): relationship to duration of infection. Radiology. https://doi.org/10.1148/radiol.2020200463

Chung M, Bernheim A, Mei X et al (2020). CT imaging features of 2019 novel coronavirus (2019-nCoV). Radiology. https://doi.org /10.1148/radiol.2020200230

Fang Y, Zhang H, Xu Y, Xie J, Pang P, Ji W (2020). CT manifestations of two cases of 2019 novel coronavirus (2019-nCoV) pneumonia. Radiology. https://doi.org/10.1148/radiol.202 0200280

Franquet T (2011). Imaging of pulmonary viral pneumonia. Radiology,2011,vol.260, 1, p.18-39. https://doi.org/10.1148/radiol. 11092149

Geoffrey D. Rubin, Linda B. Haramati, Jeffrey P. Kanne et al. (2020). The Role of Chest Imaging in Patient Management during the COVID-19 Pandemic: A Multinational Consensus Statement from the Fleischner Society. Radiology, 7 apr, https://doi.org/10.1148/ radiol.2020201365

Hansell DM, Bankier AA, MacMahon H, McLoud TC, Muller NL, Remy J (2008). Fleischner Society: glossary of terms for thoracic imaging. Radiology 246:697–722

Xie X, Zhong Z, Zhao W, Zheng C, Wang F, Liu J (2020). Chest CT for typical 2019-nCoV pneumonia: relationship to negative RT-PCR testing. Radiology, 2. doi.org/10.1148/radiol.2020200343

Xu Z, Shi L, Wang Y et al (2020). Pathological findings of COVID-19 associated with acute respiratory distress syndrome. Lancet Respir Med. https://doi.org/10.1016/S2213-2600(20)30076-X

Jeffrey P Kanne, Brent P Little, Jonathan H Chung, Brett M Elicker, Loren H Ketai (2020). Essentials for Radiologists on COVID-19: An Update—Radiology Scientific Expert Panel. Radiology. doi:10.1148/radiol.2020200527

Kunhua Li JW, Wu F, Guo D, Chen L, Zheng F, Li C (2020). The clinical and chest CT features associated with severe and critical COVID-19 pneumonia. Invest Radiol. https://doi.org/10.1097/ RLI.0000000000000672

Kunhua Li JW, Wu F, Guo D, Chen L, Zheng F, Li C (2020). The clinical and chest CT features associated with severe and critical COVID-19 pneumonia. Invest Radiol. https://doi.org/10.1097/ RLI.0000000000000672

Qian L, Yu J, Shi H (2020). Severe acute respiratory disease in a Huanan seafood market worker: images of an early casualty. Radiology: Cardiothoracic Imaging. https://doi.org/10.1148/ ryct.2020200033

Ming-Yen Ng, Elaine YP Lee, Jin Yang et al. (2020). Imaging Profile of the COVID-19 Infection: Radiologic Findings and Literature Review. Radiology: Cardiothoracic ImagingVol. 2, No. 1doi.org/10.1148/ryct.2020200034

Pan F, Ye T, Sun P et al (2020). Time course of lung changes on chest CT during recovery from 2019 novel coronavirus (COVID-19) pneumonia. Radiology. https://doi.org/10.1148/radiol.2020200370

Song F, et al. (2020). Emerging Coronavirus 2019-nCoV Pneumonia. Radiology. 1. doi.org/10.1148/radiol.2020200274

Song F, Shi N, Shan F et al (2020). Emerging coronavirus 2019-nCoV pneumonia. Radiology. https://doi.org/10.1148/radiol.2020200274

Wang D, Hu B, Hu C et al (2020). Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. JAMA. https://doi.org/10.1001 /jama.2020.1585

Wong K, Antonio GE, Hui DS et al (2003). Thin-section CT of severe acute respiratory syndrome: evaluation of 73 patients exposed to or with the disease. Radiology 228:395–400

Zheng Ye, Yun Zhang, Yi Wang et al. (2019). Chest CT manifestations of new coronavirus disease (COVID-19): a pictorial review. European Radiology, https://doi.org/10.1007/ s00330-020-06801-0