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The Efficacy of Chest X-Ray for the Diagnosis and Follow-up in Young Adult COVID-19 Patients with Mild Dyspnea No Comorbid Diseases

Hafif Dispneli Komorbid Hastalığı Olmayan Genç Yetişkin COVID-19 Hastalarında Göğüs Röntgeninin Tanı ve Takipteki Etkinliği

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Abstract

We investigated whether Chest X-Ray (CXR) could replace computed tomography (CT) modality in the diagnosis and during the treatment of young adult COVID-19 patients with mild dyspnea with no comorbid diseases. This retrospective study involved an examination of the records of a total of 956 patients hospitalized between March 1, 2020, and May 15, 2020. The study included a total of sixty-four COVID-19 patients who underwent a CXR at admission and CT imaging within 24 hours, aged 21-60 years with mild dyspnea with no comorbid diseases. The diagnosis of infection was confirmed by the polymerase chain reaction test in all cases. The first CXR and CT images at the time of admission were evaluated in terms of lesions and localization. The clinical-radiological course of the disease was also statistically evaluated. CT was normal in 18/64 (28.1%) patients, all of whom also had normal CXR. The rest of the patients 46/64 (71.9%) with an abnormal CT, the CXR was normal in 18/46 (39.1%) and abnormal in 28/46 (60.9%). The time between the onset of complaints and admission to the hospital in patients with abnormal and normal CXR was 3.5±2.3 days and 2.1±1.1 days respectively and this difference was statistically significant (p=0.004). The hospital stay durations of the patients with abnormal and normal CXR was 9.6±3.5 and 9.5±3.4 days (p=0.928), respectively, and was not statistically significant. In conclusion, in the case of early admission to the hospital, there is not a significant difference between using CXR or CT in the management of young adult COVID 19 patients with mild dyspnea no comorbid disease. Therefore, the use of CXR in these patient groups will reduce the burden of CT units in pandemic conditions with limited resources.

Keywords: Chest X-ray, Ground-glass opacity, Computed tomography, COVID-19.

Özet

Bu retrospektif çalışmada, komorbid hastalığı bulunmaksızın hafif nefes darlığı olan genç erişkin COVID-19 hastalarının tanı ve tedavileri sırasında göğüs röntgeninin bilgisayarlı tomografi (BT) yönteminin yerini alıp alamayacağını araştırdık. Çalışmada 1 Mart 2020 ile 15 Mayıs 2020 tarihleri arasında hastaneye yatırılan toplam 956 hastanın kayıtları incelenmiştir. Çalışmaya, kabul sırasında göğüs röntgeni çekilen ve 24 saat içerisinde BT görüntülemesi yapılan, 21-60 yaşları arasında hafif nefes darlığı olan ve komorbid hastalığı olmayan toplam altmış dört COVID-19 hastası dahil edildi. Tüm vakalarda enfeksiyon tanısı polimeraz zincir reaksiyonu testi ile doğrulandı. Başvuru anındaki ilk göğüs röntgeni ve BT görüntüleri lezyonlar ve lokalizasyon açısından değerlendirildi. Hastalığın klinik-radyolojik seyri de istatistiksel olarak değerlendirildi. Hastaların 18/64'ünde (%28.1) BT normaldi ve hepsinde normal göğüs röntgeni vardı. Hastaların geri kalanı (46/64; %71.9) anormal BT'ye sahipti ve göğüs röntgeni raporları bu hastaların 18/46'sında (%39.1) normal ve 28/46'sında (%60.9) anormaldi. Anormal ve normal göğüs röntgeni olan hastalarda şikayetlerin başlaması ile hastaneye başvuru arasındaki süre sırasıyla 3.5±2.3 gün ve 2.1±1.1 gün olup fark istatistiksel olarak anlamlıydı (p=0.004). Anormal ve normal göğüs röntgeni olan hastaların hastanede yatış süreleri sırasıyla 9.6±3.5 ve 9.5±3.4 (p=0.928) gün idi ve istatistiksel olarak anlamlı değildi. Sonuç olarak, hastaneye erken başvuru durumunda hafif dispnesi olan ve komorbid hastalığı olmayan genç erişkin COVID-19 hastalarının yönetiminde göğüs röntgeni veya BT kullanımı arasında anlamlı bir fark yoktur. Bu nedenle, bu hasta gruplarında göğüs röntgeni kullanımı, sınırlı kaynaklarla pandemi koşullarında BT ünitelerinin yükünü azaltacaktır.

Anahtar Kelimeler: Göğüs röntgeni, Buzlu cam opasitesi, Bilgisayarlı tomografi, COVID-19.

Introduction

In some COVID-19 cases, the presence of viral pneumonia imaging findings in computed tomography (CT), despite with negative reverse transcription-polymerase chain reaction (RT-PCR) test results, making CT the significant method [1–7]. In many cases, even though CT offers higher sensitivity than the optimum standard PCR test, it is not recommended as a scanning method [1,2,6,8].

A more significant part of the COVID-19 patient population comprises adults aged 20–60 [9,10]. This patient population has not only low comorbidities but also a low rate of mortality from COVID-19. For young adults suspected of COVID-19 with mild symptoms and no comorbid diseases, a chest X-ray (CXR) is recommended as an initial approach for thoracic imaging [1,10]. On the other hand, CT should be an advanced imaging method in clinical progression of the patients with a positive RT-PCR test [1,2,5,8].

Since COVID-19 is heterogeneous in nature, resulting in a relatively low number of patients infected through a sporadic spread in some countries while significant numbers of patients infected through community spread in others [1]. In countries with a high number of cases, the delivery of healthcare services may be interrupted, and healthcare personnel may become infected due to shortages of critical resources, including working staff, personal protective equipment, COVID-19 test kits, bed capacity, ventilators, and imaging instruments [1].

The thoracic imaging of COVID-19 patients is carried out as per the guidelines prepared by each healthcare institution considering their conditions, based on such variables as respiratory complaints, pre-test possibility, risk factors for disease progression, and the availability of critical resources in the hospital [1].

In this study, we investigated whether CXR could replace CT modality in the diagnosis and during the treatment of young adult COVID-19 patients with mild dyspnea without comorbidities.

Material and Method

This retrospective study was approved by the University of Health Sciences, Gülhane Training, and Research Hospital Ethics Committee. Written consent was waived.

Patients

A total of 956 patients hospitalized in a tertiary hospital between March 1, 2020, and May 15, 2020, were examined. Of these, 64 patients aged 21-60 years who complained of mild dyspnea (respiratory rate <30 / min, SpO_2 in room air> 90%), who were confirmed to have COVID-19 by RT-PCR, and who underwent a CXR at the time of admission and a CT scan within 24 hours were accepted suitable for the study and were included in the study (Figure 1). Patients who didn't fulfill these criteria were excluded from the study. The entire study population consisted of patients who were hospitalized and started treatment. The national guideline administered the COVID-19 treatments of the patients. The patients' first CXRs at the time of admission and CT scan images were evaluated. Also, CXR and/or CT images taken during the hospital stay were assessed by comparing the clinical features of the patients in terms of radiological progression or regression. These images were evaluated in terms of the presence of the lesion, lesion type (ground-glass opacity (GGO) or consolidation), and localization (zone and central-peripheral distribution). The differences between imaging findings and time between the onset of symptoms and time of admission to the hospital, hospital stay, and clinical-radiological course of the disease were statistically evaluated.

X-Ray Imaging

All patients were imaged using a computerized radiography (CR) technique using a mobile X-ray device (GE Healthcare Mobile X-ray: Ukiah Valley AMX 240) during hospitalization and follow-up. CXRs were obtained in the posterior-anterior (PA) projection.

CT Imaging

Thorax CT images were obtained using a 64-scanner MDCT (Aquilion ONE, Toshiba Medical System, Tokyo, Japan) without contrast media usage. All patients were scanned in the supine position, holding the breath at the end of the inspiring and covering the entire rib cage from apex to basal. Automatic tube current modulation (100-400 mA) with 100kV or 120kV tube voltage was used. The section thickness was 1.0-3.0 mm, and the reconstruction matrix size was 512 × 512.

Roentgen Evaluation

All CXR images were examined in consensus by two radiologists, E.G. and F.C., who had 3 and 10 years of experience in thoracic imaging. Disagreements in the interpretation were resolved by consensus. The scans were reported with a description of the glossary of Fleischner Society. Concerning the distribution of lesions; 1) Peripheral and/or central involvement was recorded (the border was considered the middle of the distance between the outer edge of the lung and the hilum), 2) Each lung was divided into three zones: Lower zone, from costophrenic sulcus to the lower hilar marks, middle zone, from the lower hiler marks to the upper hiler marks, upper zone, from the upper hiler mark to the apex [5,10–12].

CT Evaluation

All CT images were examined by two radiologists, U.B. and M.T., with more than ten years of experience in thoracic imaging. Disagreements in interpretations were resolved by consensus. Lesion descriptions for pneumonic infiltration were made with the nomenclature specified by the Fleischner community [11,13]. Only GGO and consolidation, which are the two most frequently reported lesions in the CT scans, were assessed. Lesion/lesions was/were categorized as consolidation if there was an onset of consolidation of any size within the GGO density lesions [2].

Concerning the distribution of lesions, both lungs were divided into three zones, and the lesions were recorded as centrally and/or peripherally located [2,14]. Lung zones were denominated as; the upper zone (above the carina), the middle zone (below the carina to the inferior pulmonary vein), and the lower zone (below the lower pulmonary vein). One-third of the parenchyma close to the pleura was considered as peripheral, two-thirds of the perihilar parenchyma was regarded as central.

Statistical analysis

Relationships of investigated parameters were evaluated statistically. The mean and ± standard deviation (SD) for all variables were calculated. SPSS analyzed the obtained data for Mac 20.0 package program (SPSS Inc, Chicago, IL, USA). Frequency and percentage for discrete data; mean±SD for continuous variables were used in descriptive statistics. The normality of the continuous variables was analyzed with the Kolmogorov-Smirnov test. The Chi-Square test was used for the analysis of all categorical variables. Student's T-test analyzed mean values with parametric distribution between groups, and Mann-Whitney U tests compared non-parametric distributions. P-value less than 0.05 was considered statistically significant, with a 95% confidence interval.

Results

The study population consisted of 64 patients, 75% (n=48) of the patients were male and 25% (n=16) were female, with the mean age 40.6±12.6 (21-60).

CT was normal in 18/64 (28.1%) patients, and all of these patients also had normal CXR. While the CT of 46/64 (71.9%) patients was abnormal, only 28/64 (43.8%) patients had abnormal CXR findings (Figure 2). In 46/64 (71.9%) patients with abnormal CT, 18/46 (39.1%) had normal CXR, and 28/46 (60.9%) had abnormal CXR findings. In 18/46 (39.1%) patients with normal CXR, 17/18 (94.4%) had GGO, and 5/18 (27.8%) had consolidation in their CT scans (Figure 3). The rate of GGO and consolidation in the CTs of 28/46 (60.9%) patients with abnormal CXR was 75% (21/28) and 78.6% (22/28), respectively. The properties and distribution of the lesions in 46/64 (71.9%) patients with abnormal CT by normal-abnormal CXR is summarized in Table 1.

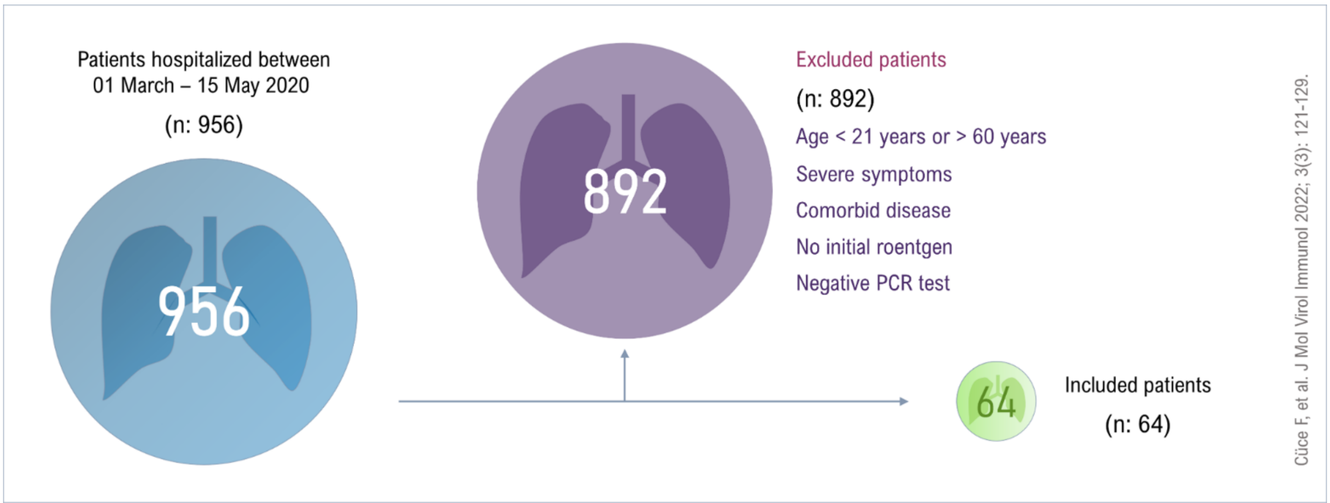

Figure 1. Flow of diagram of the retrospective study (PCR: Polymerase Chain Reaction).

Concerning the lesion distribution characteristics in the lungs, both CT and CXR revealed an increase in the number of lesions from the upper zone to the lower zone, with most lesions being detected in the lower lobes (Table 2). However, among the 27/64 patients with consolidation in any localization on CT, 24 had upper zone involvement (12 in the right, 12 in the left), and pathological opacity in the upper zones could be observed on CXR in all patients. Furthermore, among the 38/64 patients identified with GGO in any localization on CT, there were right and left upper zone involvements in 14 and 16 of them, respectively. The CXR provided a false negative result in 3 of all the patients who had GGOs in upper zones.

When eighteen of 64 (39.1%) patients with abnormal CT and normal CXR were evaluated in detail, GGO was seen more commonly than consolidation and mostly located in the lower lobe and peripherally (Table 2). While there was no false negativity with CXR in upper zone consolidations in both lungs, in 33.3% with lower zone consolidations and 38.9% with central and peripheral consolidations, CXR was a false negative (Figure 4). However, the rate of false negativity was lower for consolidation than for GGO (Figure 5).

The mean time between the onset of complaints and admission to the hospital was 2.7±1.8 days. In patients with normal CXR, the time between the beginning of complaints and admission to the hospital was 2.1±1.1 days. In contrast, in patients with abnormal CXR, it was 3.5±2.3 days, and this difference was statistically significant ($p=0.004$).

The mean hospitalization duration was 9.5±3.4 days. While analyzing the subgroups, it was seen that 39/64 (60.9%) patients had a hospitalization period of more than nine days. CXR showed abnormal findings in 18/39 (46.2%) of these patients and was normal in 21/39 (53.8%). The hospitalization durations of patients with abnormal and normal CXR were 9.6±3.5 and

9.5±3.4 days, respectively, and were not statistically significant (p=0.928). Moreover, of the 39 patients (60.9%) who were hospitalized for more than nine days, 29 (74.4%) had abnormal CT findings, and 10 (25.6%) had normal CTs. The hospitalization durations of patients with abnormal and normal CT were 11.8±2.6 and 11.5±2.5 days, respectively, and the difference was not statistically significant (p=0.756). Radiological progression was observed in only two of the patients, while none of them showed clinical progress.

Table 1. Properties and distribution of lesions in CT scans according to normal-abnormal CXR.

CT		CXR		Total, n
		Normal, n (%)	Pathologic, n (%)	
Abnormal		18 (39.1)	28 (60.9)	46
Lesion type	GGO	17 (44.7)	21 (55.3)	38
	Consolidation	5 (18.5)	22 (81.5)	27
Localization	Central	7 (25.9)	20 (74.1)	27
	Peripheral	14 (34.1)	27 (65.9)	41
Right lung	Upper	3 (15.8)	16 (84.2)	19
	Middle	6 (19.4)	25 (80.6)	31
	Lower	13 (37.1)	22 (62.9)	35
Left lung	Upper	3 (15)	17 (85)	20
	Middle	4 (16)	21 (84)	25
	Lower	3 (11.5)	23 (88.5)	26

CT: Computed tomography. CXR: Chest X-ray. GGO: Ground-glass opacity. n: Number.

Table 2. Distribution of abnormal lesions and false-negative CXR patients with abnormal CT findings.

		Abnormal CXR and abnormal CT results		False-negative CXR (n=18) patients	
Localization		CT (n=46), n (%)	CXR (n=28), n (%)	GGO, n (%)	Consolidation, n (%)
Right lung	Upper	19 (41.3)	6 (21.4)	3 (16.7)	0
	Middle	31 (67.4)	10 (35.7)	5 (27.8)	2 (11.1)
	Lower	35 (76.1)	22 (78.6)	12 (66.7)	5 (27.8)
Left lung	Upper	20 (43.5)	4 (14.3)	3 (16.7)	0
	Middle	25 (54.3)	9 (32.1)	4 (22.2)	1 (5.6)
	Lower	26 (56.5)	15 (53.6)	3 (16.7)	1 (5.6)
Central		27 (58.7)	14 (50)	7 (38.9)	2 (11.1)
Peripheral		41 (89.1)	24 (85.7)	13 (72.2)	5 (27.8)

CT: Computed tomography. CXR: Chest X-ray. GGO: Ground-glass opacity. n: Number.

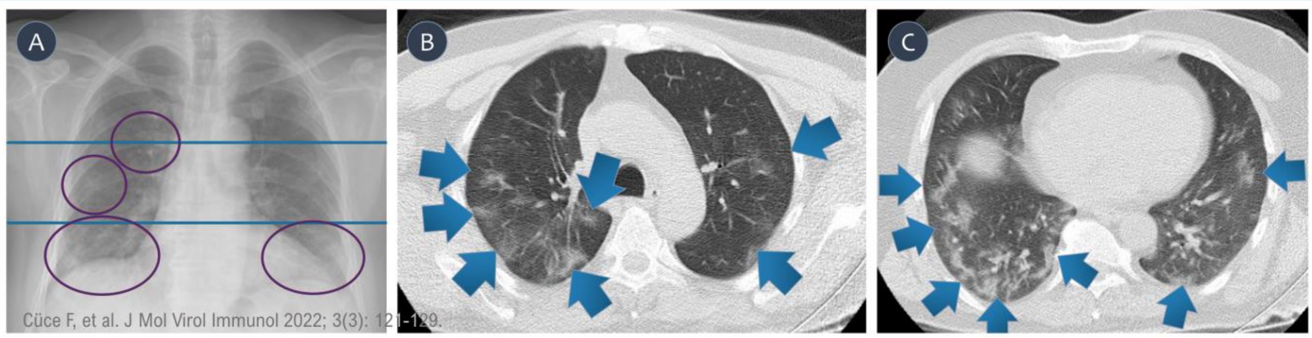

Figure 2. A 43-year-old male patient with COVID 19 and without any comorbid disease presenting with mild dyspnea. (**A**) In CXR, faint-border opacities are observed in the right upper and middle zone and bilateral lower zones. Thoracic CT in the axial plane shows central and peripherally localized ground glass density lesions in bilateral upper (**B**) and lower zones (**C**).

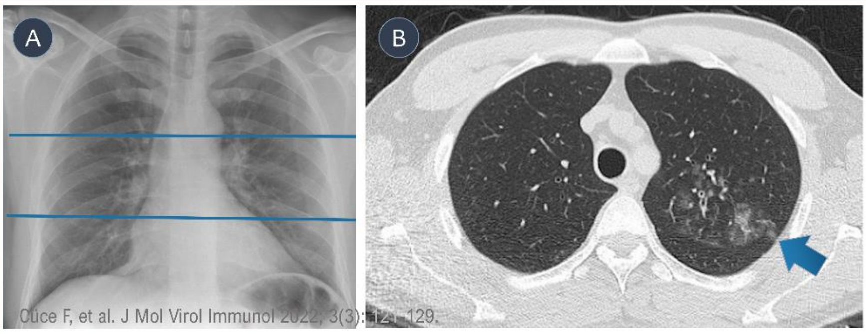

Figure 3. A 23-year-old male patient with COVID 19 complaining of mild dyspnea. (**A**) CXR is false-negatively normal. (**B**) Ground-glass densities compatible with active infiltration are observed in the left upper zone in the axial plane of thoracic CT.

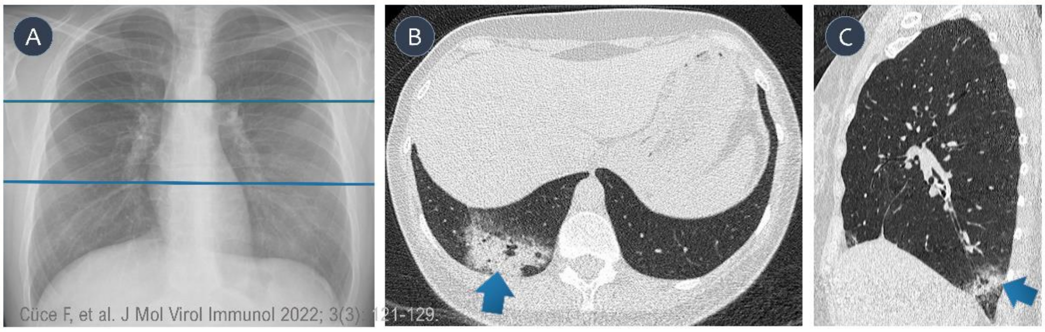

Figure 4. A 34-year-old male patient with COVID 19 complaining of mild dyspnea. (**A**) CXR is false-negatively normal. (**B**) Axial plane thorax CT shows an air bronchogram containing consolidation in the posterior segment of the right lower zone. (**C**) Sagittal multiplanar reconstruction (MPR) image shows that the lesion is located peripherally towards the posterior costodiaphragmatic sinus. The lesion cannot be distinguished in CXR due to opacity belonging to the diaphragm.

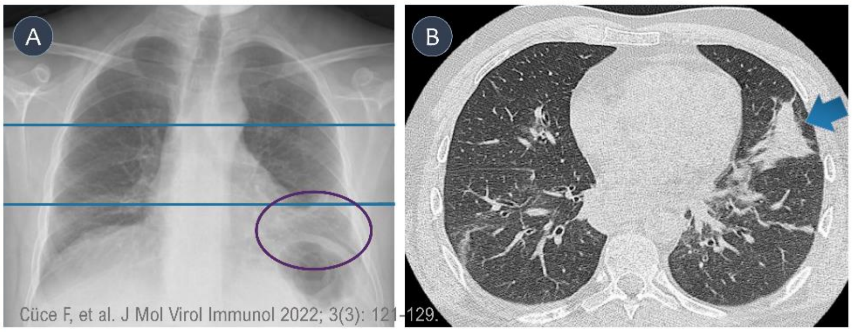

Figure 5. A 38-year-old female patient with COVID 19 complaining of mild dyspnea. (**A**) There is an increased opacity in CXR in the lower-left zone. (**B**) The homogeneous hyperdense consolidated atelectatic parenchyma in the lower left zone in the axial plane of the thorax CT is consistent with the opacity in the CXR. While the heart and diaphragm can obscure GGO-type lesions, consolidation, which is one of the later signs of the disease, can be detected with CXR due to its more opaque appearance.

Discussion

CXR could be preferred instead of CT in the diagnosis and follow-up of young adult COVID 19 patients with mild dyspnea no comorbid disease. However, the CT's sensitivity was 71.9% (46/64), and CRX was 43.8% (28/64) in our patient population. These values are lower than those reported in the literature, which is attributed to the characteristics of our patient population. In terms of distribution, the lesions were mostly peripherally located in lower zones, as reported in the literature [15,16]. In our study, all of the upper zone consolidations on CT were detected by CXR, whereas in patients with GGOs, there were false-negative CXRs (Figure 3). As a result, in false-negative CXR, it was observed that lesions were mostly in the lower zones, and the lesion type was mostly GGO, which is consistent with the literature [5]. The false negativity in question is due to both lower zones being covered, especially by the heart and diaphragm on PA CXR, and the GGO, which is the early sign of disease being sufficiently opaque to be noticed on the radiograph.

In the present study, in the case of early admission to hospital, there is not a significant difference between using CXR or CT in the management of these patients. It has been suggested in the literature that CXR can be used to diagnose and follow-up patients with lower respiratory tract infections [17]. Although the sensitivity of CXR in the diagnosis of COVID-19 is low [18], it is stated that both early hospitalization and early treatment may positively affect the healing process in addition to diagnostic imaging method [7].

Pneumonia is the most common presentation of COVID-19 [4]. The appearance of pneumonia that can be detected on CXR is in the form of opacity due to consolidation [16,19]. The sensitivity of CXR in a COVID-19 diagnosis is 33–69%, lower than that of CT [5]. GGO, the initial lesion of infection, is a reason for false negativity on CXR. Therefore, CXR is the secondary importance in early diagnosis in comparison with CT, which has a sensitivity as high as 97-98% [20,21]. In countries with a lockdown in the pandemic, the inability of those with mild symptoms to reach the hospital causes clinical progression. Ongoing to the hospital in the late period, CXR positive results increase in these patients [9]. The chance of early admission to the hospital is a factor that may decrease the sensitivity of CXR.

The most effective approach in the fight against the COVID-19 outbreak is the early identification and efficient management (isolation of suspected cases, disinfection) of the transmission route [3]. To meet this condition in radiology departments, the American College of Radiology (ACR) recommends the use of portable X-ray machines, given the minimized risk of disease spread and the reduction of the patient load of CT units [22]. Portable CXR should be preferred as the initial imaging method due to the advantage of less ionizing radiation when compared to CT, the ease of equipment sterilization, and the ease of transfer to the polyclinics and wards, reducing the need for patient transfers to the radiology department [23,24]. CXR has the additional advantage of being useful for the diagnosis of other conditions that can mimic COVID-19 pneumonia, such as pulmonary edema, pneumothorax, pleural effusion, and lobar pneumonia that is common in winter [25].

Institutions such as the Fleischner Society, the American College of Radiology (ACR), and the Society of Thoracic Radiology (STR) do not recommend CT for screening and diagnostic testing on a large scale for COVID-19 concerning both infection control and diagnostic efficacy and highlight that CXR should be preferred, especially in young adults with mild symptoms with no comorbid diseases; same as our study emphasizes.

The primary limitation of the present study is its retrospective design, which can lead to observer bias in the interpretation of the results. Other limitations of our research consist of the small patient population and lack of data about some variables that may be important for the prognosis of the disease, such as smoking and obesity.

Conclusion

In line with the recommendations of professional radiological institutions in the available literature, the present study suggests that CXR could be used in the diagnosis and follow-up of young adult COVID 19 patients with mild dyspnea no comorbid disease. In the case of early admission to the hospital, there is not a significant difference between using CXR or CT in the management of these patients. Therefore, the use of CXR in these patient groups will reduce the burden of CT units in pandemic conditions with limited resources without causing any further medical problems.

Conflict of interest: The authors declare that there is no conflict of interest. The authors alone are responsible for the content and writing of the paper. **Financial disclosure:** There is no financial support to this study.

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