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Evaluation of computed tomography findings in patients with COVID-19

Cyrus Emir-Alavi[1], Zakiyeh Jafaryparvar[1], Mohammad Amin Khajavi Gaskarei[1], Sahar Heidary[1], Hossein Hemmati[1], Tofigh Yaghubi Kalurazi[1], Ali Alavi Foumani[2], Siamak Rimaz[1], Abbas Sedighi-Nejad[1], Hoda Sabati[3], Behnaz Ghanbar-Moghaddam[1], Hossein Khoshrang[1], Maryam Ahmadpour[4], Seyedeh Maral Mousavi[1], Zahra Golamalipour Garfami[4], Zobin Souri[1*], Mohaya Farzin[1*]

1. *Razi Clinical Research Development Unit, Razi Hospital, Guilan University of Medical Sciences, Rasht, Iran*
2. *Inflammatory Lung Diseases Research Center, Razi Hospital, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran*
3. *Biotechnology and Biological Science Research Center, Faculty of Science, Shahid Chamran University of Ahvaz, Ahvaz, Iran*
4. *Student Research Committee, School of Nursing and Midwifery, Guilan University of Medical Sciences, Rasht, Iran*

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ABSTRACT

Due to the coronavirus disease (COVID-19) pandemic the high-resolution computed tomography (HRCT) become a relatively available and non-invasive method used for identifying COVID-19 cases. This study aimed to evalute HRCT findings of patients with COVID-19. Totally, 92 patients confirmed cases of COVID-19 by RT-PCR were included in the study. In addition to their demographic and clinical information, their HRCT findings were collected for evaluation. Among 92 patients (47 men, 45 women), the earliest symptoms included cough 81.5%, fever 67.4%, and muscle pain 58.7%. Six patients required intubation and mechanical ventilation at some point during their hospital stay. The most common HRCT findings in our study were grade 4 peripheral lesion 87%, bilateral 95.7%, mixed 76.08%, ground-glass opacity (GGOs) 75%, left lower lobe 94.56%. Among 92 patients, we had some inconsistent findings including two patients with cardiomegaly, three patients with pleural effusion, and bilateral pleural effusion in only one patient. According to the results, concluded that peripheral, bilateral, mixed, GGOs, left lower lobe involvement are important findings in most patients with COVID-19. We suspect that the disease has more severe lung involvement in men and less involvement in women, which needs further investigation.

Corresponding Author(s):
Dr. Mohaya Farzin, Ph.D / Dr. Zobin Souri, MD
Address: *Razi Hospital, Guilan University of Medical Sciences, Rasht, Iran*
Tel: *+98 11 2471138*
E-mail: *dr.mohayafarzin@gmail.com / zoubin.souri62@yahoo.com*

1. Introduction

In December 2019, a new pathogen coronavirus disease (COVID-19) was identified in Wuhan, Hubei Province, China that caused pneumonia and death [1, 2]. COVID-19 is one of the positive-strand RNA viruses that genetically are similar to the acute respiratory syndrome virus SARS-associated coronavirus (SARS-CoV) and the Middle East respiratory syndrome (MERS-CoV) [1, 3, 4]. Following the spread of the virus to other countries such as South Korea, Italy, Iran, and Japan and reporting a death in infected people there the World Health Organization (WHO) declared it as a pandemic and named it COVID-19 [3, 5]. Until the date of writing this scientific research, according to WHO, 35,027,546 cases of COVID-19 have been confirmed, including 1,034,837 death [6]. COVID-19 and SARS have many close clinical characteristics [3]. The spread and contagion of the virus happen through large droplets created during sneezing and coughing of asymptomatic and asymptomatic patients [7]. The virus can survive on different surfaces such as metal, glass, or plastic for up to 9 days and infect people by touching the nose, eyes, and mouth [5, 7]. After contact with the virus, symptoms may appear within 2 to 14 days [8]. The transmission rate of SARS-CoV-2 is high between families and friends who had close contact with patients or asymptomatic carriers even with a low infective dose [9]. Elderly persons with comorbidities or underlying diseases such as diabetes, hypertension, or cardiovascular diseases (CVD), are at serious and greater risk because these diseases may weaken the immune system [3, 9, 10]. Although everyone is at risk, the average age of patients was between 47–59 years old, of which women make up 41.9–45.7% of patients [7, 9].

COVID-19 has various clinical features, from an asymptomatic state to acute respiratory distress syndrome until multi-organ dysfunction [7]. Common clinical symptoms of COVID-19 are fever, nonproductive cough, dyspnea with or without diarrhea, myalgia, fatigue, usually normal or reduced leukocyte amounts, and radiographic data of pneumonia, which are similar to the symptoms of SARS-CoV and MERS-CoV contagions [1, 4, 7]. The most and main common symptom for screening is fever [3]. Pneumonia and kidney failure may happen in severe cases which lead to death [10]. In the second week, the infection progresses to hypoxemia, respiratory problems, and acute respiratory distress syndrome (ARDS), which leads to the need for mechanical ventilation in the intensive care unit (ICU) with isolated services [1]. Patients should drink plenty of fluids and electrolytes and appropriate oxygen therapy or treatment should be provided through the oxygen mask, nasal cannula, or high flow nasal oxygen therapy. In this situation, checking some parameters like heart rate, blood pressure, pulse oxygen saturation, and respiratory rate is essential [10].

COVID-19 diagnostic tests are varied and include nucleic acid detection, computed tomography (CT) scan, and immune identification technology [4, 10]. CT imaging normally appearances infiltrate ground-glass opacities (GGOSs), and subsegmental consolidation [7] Single or numerous agglomerated or scattered patchy GGOSs segregated by grid-like condensed or honeycomb-like interlobular septa and pulmonary consolidation with air bronchogram. high-resolution computed tomography (HRCT) compared to conventional CT scan has a higher diagnostic power to examine the parenchyma in detail and determine inflammation from fibrosis [11]. One of the diagnostic methods used by radiologists is chest CT scan images to follow for confirmed cases from early to critical stages [12]. CXR and CT scans are an alternative to help with the constraint and the inconvenient process [13].The results may differ according to disease phase, patient age, and immune status at the time of imaging [10]. For identification, HRCT is more sensitive than CXR [14], and this is necessary for quick diagnosis and assessment of COVID-19 patient's severity, discovering lung deformities, clinical classification, finding of pulmonary problems, and follow-up after discharge [4, 15].

Clinical use of HRCT as valid preliminary test required to classify the radiological features of COVID-19. Despite the previous reports, observations were different in populations. Therfore, in this study, we examined the findings of HRCT and comparing with the clinical course of patients with COVID-19 in the north of Iran.

2. Materials and Methods

2.1 Study design and patients

This retrospective cross-sectional study was conducted in 2019-2020 on 92 cases of COVID-19 confirmed by RT-PCR in Razi Hospital, Rasht, Iran. The study was performed in accordance with the declaration of Helsinki and approved by the Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1398.543). Also, written informed consent to participate in the study was obtained from participants. Their demographic and clinical data including age, sex, underlying diseases, signs and symptoms, length of hospital stay, hospital outcome (mechanical oxygen demand (intubation) - blood oxygen saturation, recovery or death, and HRCT radiographic results were recorded and analyzed. The criterion for patient admission was the presence of a definite laboratory result to confirm the occurrence of COVID-19 in the patient file. Patient files with incomplete information (main variables like lack of definitive result of COVID-19 and also lack of HRCT image in the file report, were excluded from the study.

2.2 Imaging analysis and quantification

Each case underwent chest HRCTexamination within 24 hours after admission. All imaging was taken by a General Hi-speed Dual CT scanner. It is then monitored and evaluated by an experienced radiologist. The imaging

procedure was performed according to the common protocol of the chest. The HRCT in axial sections was used without the contrast material with a section thickness of 2 mm. The low-dose protocol (low-dose computed tomography) with radiation conditions of Kvp = 100– 120, mAs = 50–100, and pitch = 1 mm was used. Lesion image analysis included the number of lesions, distribution of lung lobes, location of lesions in the lung, lesion size, the density of right upper lobe lesions, right middle lobe, lower right lobe, left upper lobe and lower left lobe. The location of the lesions in the lung included peripheral (if it is located in the outer third of the lung), central (inner 2/3 region of the lung), peripheral-central, and bilateral or unilateral. Lesion size was defined as: no grade, grade 1 (>1 cm), grade 2 (1<X<3 cm), grade 3 (3cm to <50% of the lobe), and grade 4 (50-100% of lobes). The presence of ground-glass opacities, consolidation, mixed, fibrous stripes, reticulation or interstitial thickness, air bronchogram in each patient's chest CT image were assessed as lesions density. Pleural effusion and cardiomegaly were also present. The patient puts his arm above his head and lies on the CT scanner. CT scanning started from the apex to the lowest part of the lungs in deep inspiration. The patient was told to hold his breath during the imaging.

2.3 Statistical analysis

In this study, the collected data is recorded in an Excel program and then coded and entered into SPSS software. Qualitative and quantitative variables (mean and standard deviation) have been described using numbers and percentages. The Kolmogorov test was used to determine the normality of the variables. If normal, parametric tests and otherwise according to the variables, qualitative research using the chi-square test and Spearman correlation coefficient can be used to determine the frequency and correlation. Patients were divided into 4 groups for more analysis according to age as follows: group 1, < 20 years old; group 2, 21–40 years old; group 3, 41–60 years old; group 4, 61–80 years old and group 5, 81–100 years old.

3. Results

In the present study, 92 patients with confirmed COVID-19 were evaluated for HRCT. They were 47 men, 45 women with a mean age of 56.52 ± 14.05. The average length of stay in hospitals was 7.2 days. Among these patients, 90 patients (8.97%) were referred to the hospital in person. Of all patients, 75 cases had not been in direct or indirect contact with other COVID-19 patients. The baseline data are recorded in Table 1.

At first presentation, the most common early symptoms in the patients with COVID-19 in the present study, were cough (75 cases, 81.5%), fever (62 cases, 67.4%), muscle pain (54 cases, 58.7%), respiratory distress (34 cases, 37%), and other cases are shown in Table 2. After antiviral treatment, 81 patients were discharged from the hospital but 11 patients died during hospitalizing.

Also, 30 of 92 patients had a history of at least one underlying disease (Table 3), which diabetes was the most common (10 cases). O_2 pressure in 25 cases was more than 93mm Hg and in 67 cases was less than 93mm Hg. Six patients required intubation and mechanical ventilation at some point during their hospital stay and three of them died. Two patients were required to undergo dialysis (Table 3).

The present study showed that HRCT image lesions size in all patients, grade 4 (50-100 % of the lobe) were the most common (Table 5). The most common grade was 4 (seventeen cases) in men, 1 and 2 grades in women (twelve cases each). In the age groups of 20-40, grade 2 and 60-80, grade 3, in 80 to 100, grade 3 were detected in HRCT. We found that lesions were more localized in the peripheral zone (80 cases, 87%). The involvement of peripheral lung lesions in the age of 40-60 was more than in other age groups. Also, lesions were involved in the peripheral-central zones in twelve cases (13%). Based on the HRCT finding, 72 patients (78.3%) had lesions in all lung lobes. Our result showed that the most common site of involvement was the left lower lobe (87 cases) at different ages and the least involved lobe was the upper left (81 cases). The most common site of involvement lobes in men was almost all of them, but in women lower left was most common. We also diagnosed 88 patients (95.7%) with bilateral lung involvement, three patients (3.3%) with only the left lung, and one patient (1.1%) with only the right lung.

Table 1: Baseline Characteristics in COVID-19 patients.

Variable	Finding
Gender	Male: 47 (51.1%)
	Female: 45 (48.9%)
Hospital reffering	EMS: 2 (2.2%)
	90 (97.8%)
Death	11 (12%)
Age (year)	56.52±14.05
Hospitalization (day)	7.2±9.93

Table 2: Clinical information of 92 patients infected with SARS-CoV-2

Variable	**Yes** No. (%)	**No** No. (%)
Contact history with COVID-19	17 (18.5)	75 (81.5)
Fever	62 (67.4)	30 (32.6)
Cough	75 (81.5)	17 (18.5)
Muscle pain	54 (58.7)	38 (41.3)
Dystress	34 (37)	58 (63)
Consciousnes	2 (2.2)	90 (97.8)
Anosmia	7 (7.6)	85 (92.4)
Lose of taste	5 (5.4)	87 (94.6)
Anorexia	1 (1.1)	91 (98.9)
Smooking	2 (2.2)	90 (97.8)

Table 3: Infected patients underlings diseases and emergency procuders information

Underlings disease	Yes No. (%)	No No. (%)
Diabetes	10 (10.9)	82 (89.1)
Heart disease	8 (8.7)	84 (91.3)
Hypertension	7 (7.6)	85 (92.39)
Kidney failure	6 (6.5)	86 (93.5)
Immunideficiency	3 (3.3)	89 (96.7)
Asthma	3 (3.3)	89 (96.7)
Cancer	2 (2.2)	90 (97.8)
Hematology	2 (2.2)	90 (97.8)
Airway diseases	2 (2.2)	90 (97.8)
Neurological disorders	2 (2.2)	90 (97.8)
Other Chronic Disease	7 (7.6)	85 (92.39)
Special actions taken		
Intubation	6 (6.5)	86(93.5%)
Oxygen saturation	25 (27.2) >93mm Hg	67 (72.8) <93mm Hg
Dialysis	2 (2.2)	90 (97.8)

Table 4: Presented findings in HRCT scan of symptomatic patients

Variable	Number	Percent
Peripheral	80	87
Peripheral-Central	12	13
Bilateral	88	95.7
Left	3	3.3
Right	1	1.1
Mixed	70	76.1
Ground glass opacity	69	75
Consolidation	52	56.5
Reticulation or interstitial thickening	50	54.3
Fibrous strips	40	43.5
Air bronchogram	16	17.4
Lower left	87	94.6
Lower right	86	93.5
Upper right	86	93.5
Middle right	83	90.2
Upper left	81	88

We also analyzed the characteristics of each patient lesion. A total of 297 lesions were observed in HRCT, of which 70 were mixed and 69 were GGO lesions. The most common lesion in men was mixed, but in women the most common lesion was GGOs. For each patient lesion, an air bronchogram was examined, which was a total of 16 cases. The bronchogram was observed in men (11 cases) more than women (5 cases). Among 92 patients, we had some inconsistent findings including two patients with cardiomegaly, three patients with pleural effusion, and bilateral pleural effusion in only one patient.

4. Discussion

CT images with a sensitivity of 98% play a significant role in the distinction and assessment of COVID-19 [16]. The SARS-CoV-2 disease is considered a global threat with a high infectious rate and CT imaging has an important role in its rapid diagnosis and evaluation [17, 18]. To our knowledge, this is one of the first study about hospitalized patients from Guilan province by HRCT for diagnosis and evaluation. The present study was performed HRCT on 92 patients and recorded signs of involvement in the CT images. In the present study, the cough was found to be the most common clinical manifestation 81.52 %. Other studies have reported 41 to 100 percent [19]. The prevalence of this finding in other studies varied from 90% (5) The most common symptoms have been reported in other febrile studies [10, 18, 20]. Shortness of breath was the most common symptom in patients [21]. Our results showed that 32.60% of patients had a history of underlying disease, which in other studies ranged from 18.48 to 34.9% [21, 22]. In other studies, the highest share of underlying diseases has been reported in diabetic patients. [21] Heart patients in our study are 8.7%, which in other studies varies between 2 and 9.7% [23]. In our study, 6 out of 92 patients 6.52% required mechanical ventilation, which was consistent with the results of other studies[8].

The most common findings presented in patients were peripheral distribution, and involvement of the lower left lobe, grade 4 of mixed lesion size. The mixed prevalence in our study population was 76.1%, and in the systematic and meta-analysis study that was examined, it was reported to be about 0.43% [24]. The most common presented findings in patients were ground-glass opacity, peripheral distribution, and posterior distribution. The prevalence of ground-glass opacity in the study population was 75%, which varied from 41 to 100% in other studies [8, 17, 23, 24]. GGO with 87.3% had the highest percentage in CT images and the peripheral area was the second most common finding in this study which was observed in 87% of the study population. This rate has been reported in 57.1% and 82.4% in other studies, which is consistent with our study [17, 24]. Our results showed the most site of the involved lobe was the left lower lobe in 94.6% of the population, in similar with a previous systematic and meta-analysis study [24]. In another study, the lesions of patients were mainly located in the lower lobe of the right lung [20]. Our study used a satisfactory sample size due to the epidemic, which is one of the strengths of the present study.

Based on the findings, it can be concluded that peripheral, bilateral, mixed, GGOs, left lower lobe involvement are important findings in most patients with COVID-19. We suspect that the disease has more severe lung involvement in men and less involvement in women, which needs further investigation.

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Author contributions

Conceived and designed the analysis: CEA, HH, ZJ, TY, AA, SR, AS, HK, ZS, MF; Collected the data: ZJ, AK, TY, AA, SR, AS, BG, MA, MM, ZG, MF; Contributed data or analysis: ZJ, HS, BG, MA, ZG, ZS, MF; Wrote and revision the paper: CEA, AK, HH, AK, HS, HK, ZS, MF. All authors read and appoved the final version of manuscript.

Competing of interest

The authors declare that they have no conflict of interest concerning this article.

Ethical declarations

The study was performed in accordance with the declaration of Helsinki and approved by the Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1398.543). Also, a written informed consent to participate in the study was obtained from participants.

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