

Clinical, laboratory and chest computed tomography aspects of hospitalized patients with COVID-19 in northern Iran

ali sharifpour¹, sepideh Safanavaei¹, Rabeeh Tabaripour², fatemeh Taghizadeh³, maryam nakhaei¹, atikeh abadi¹, Mahdi Fakhar², Elham Sadat Banimostafavi¹, Sayed Rasooli¹, Masoud aliyali¹, Siavash abedi¹, and Hossein Hossein Mehravaran¹

¹Mazandaran University of Medical Sciences Faculty of Medicine

²Affiliation not available

³Mazandaran University of Medical Sciences

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Abstract

The clinical symptoms, blood laboratory data, O₂ saturation and high resolution computed tomography (HRCT) findings are critical factors in diagnosis of COVID-19 infection. In this study, 105 hospitalized patients suspected of having COVID-19 were evaluated. Finally, the data of 83 confirmed cases by HRCT and RT-PCR were analyzed. 61.40% of the patients had a comorbidity disease. 89.20% had fever, 92.00% cough, 91.40% dyspnea. Abnormal CRP seen in 77.80% of the patients following by 66.70% lymphopenia, and 60.30% neutrophilia. Also, ALP (abnormal vs. normal) and score of HRCT assessment variables had a significant effect on the positiveness of HRCT findings. 87.95% had abnormal HRCT with 41% bilateral multilobar patchy ground glass opacity (GGO). Moreover, there was a statistically significant association between level of O₂ saturation and HRCT results. Our findings showed that male patients with middle age and comorbidity disease were more susceptible to the COVID-19 infection. Additionally, clinical features, blood laboratory findings, O₂ saturation and HRCT findings are critical factors in prognosis of COVID-19 infection.

Introduction

A current outbreak of pneumonia related to a novel coronavirus, termed severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was reported in Wuhan, Hubei province, China in December 2019. The infection spread across other countries round the world (Zhu et al.). On January 30, 2020, the World Health Organization (WHO) stated the outbreak a Public Health Emergency of International Concern (Sohrabi et al., 2020).the symptoms of COVID-19 can be fever, dry cough, fatigue, shortness of breath, myalgia or even no symptoms (Diao et al., 2020, Wan et al., 2020, Shang et al., 2020, Huang et al., 2020, Zarghami et al., 2020).likewise, the studies revealed that older age, male gender, leukocytosis, and Blood laboratory findings, also, comorbidities such as high lactate dehydrogenase level, cardiac injury, hypertension, diabetes mellitus, hypothyroidism, coronary artery disease, smoking and hyperglycemia, were related to weak prognosis in COVID-19 patients (Zhang et al., 2020b, Li et al., 2020, Zarghami et al., 2019).Though, information concerning to clinical features of COVID-19 is still making it difficult for physicians to distinguish the causative agents without related laboratory analysis(Wu and McGoogan, 2020).Furthermore, reverse transcription-polymerase chain reaction (RT-), the gold standard for confirming diagnosis of COVID-19, has some restrictions, such as false negative results and limited sampling method and the rate of high false negative and unavailability of in the early stage of the outbreak restricted fast diagnosis of infection in patients(Fang et al., 2020). The high resolution computed tomography (HRCT) of the chest is progressively recognized as a strong indicator for early diagnosis, and can be the key to the evaluation of COVID-19 suspected patients because the changes in chest imaging sometimes maybe earlier than symptoms (He et al., 2020). HRCT is

strongly recommended because it is very sensitive to detecting early disease, assessing the nature and extent of lesions (Yang et al., 2020a). Other investigators examined chest HRCTs in infected patients and found high rates of ground-glass opacities and consolidation, sometimes with a rounded morphology and peripheral lung distribution (Yang et al., 2020b, Pan et al., 2020, Chung et al., 2020).

Chest HRCT can identify the early phase lung infection (Wong et al., 2020, Kanne, 2020) and prompt larger public health surveillance and response systems (Ng et al., 2020). Currently, chest HRCT have been recommended as main evidence for confirmed clinical and laboratory diagnosis. Considering the previous studies, the purpose of the study is to make the early diagnosis, by describing the complete chest HRCT appearances, related laboratory analysis and clinical features of patients with COVID-19, who were hospitalized to the Imam Khomeini Hospital .

Patients and Methods

In this cross-sectional study, 105 patients suspected of having COVID-19 hospitalized in Imam Khomeini Hospital, during February 2020, were enrolled. Finally, the data of 83 confirmed cases by HRCT were analyzed. Demographic, clinical, HRCT features and laboratory data of the patients were extracted and analyzed. All HRCT images were reviewed blindly by 2 radiologists with working experiences to the clinical evidence. The severity of lung involvement was scored and classified into 3 categories (category 0: negative findings, category 1: less than 50% of the lung involvement, and category 2: up to 50%) of the lung involvement. The current study was reviewed and approved by the Research Ethical Committee, XXXX (IR.XXXX.REC.1399.102) .

Statistical analysis

Quantitative variables as mean \pm SD and qualitative variables also were reported as frequency (%). Chi-square and Fisher's exact tests were used for categorical variable comparison. In addition, to compare the median of quantitative variables in the two groups test was used. Then, first to determine the factors associated with the positiveness of HRCT result univariate logistic model was fitted, and those variables which had $P < 0.25$ were entered into the multiple model. Receiver operating characteristic (ROC) curves were constructed to test the ability of final model to predict the positiveness of HRCT result. All analysis was carried out in the version 20.0 and STATA Release version 12. $P < 0.05$ was considered statistically significant.

Results

The mean age of the patients was 58.12 ± 17.19 , and 46 (55.40%) were males. There was not a statistically significant difference between the mean age of men and women ($p > 0.05$). 33(89.20%) of the patients had fever, 46 (92.00%) cough, and 53(91.40%) had dyspnea. Furthermore, 6(7.23%) had chill and 9(10.84%) had myalgia (Table1). As well, analysis of the laboratory results showed that abnormal WBC was seen in 34(42.00%) of the patients, 54 (66.70%) lymphopenia, 47(60.30%) neutrophilia, 56(77.80%) abnormal C-reactive protein (CRP), 18(22.00%) abnormal platelet count test (), 40(66.70%) abnormal lactate dehydrogenase (LDH), and 53(80.30%) had abnormal erythrocyte sedimentation rate (ESR). Moreover, the mean of O₂ saturation was 93.89 ± 4.77 , while, 37(44.60%) of them had insufficient O₂ saturation. Furthermore, 32(54.20%) of cases had abnormal serum glutamic-oxaloacetic transaminase (SGOT), and 22(37.30%) of cases had abnormal serum glutamic-pyruvic transaminase (SGPT), and 27(46.60%) of them had abnormal Alkaline phosphatase (ALP) (Table2, Table3). Analysis of the HRCT results showed that 73 (87.95%) had abnormal HRCT as follows: bilateral multilobar patchy ground glass opacities (GGO) 16(19.30%), bilateral multilobar patchy ground glass opacities and bilateral alveolar consolidations 18 (21.70%), Pleural effusion 7(8.40%), bilateral alveolar consolidations 6(7.20%), unilateral /single lobar ground glass opacities 2 (2.40%), unilateral/single lobar alveolar consolidation 2 (2.40%), centrilobular nodules/tree in bud opacities 1(1.20%), other mixed disease13 (15.60%) and any other findings 3 (3.60%).

Moreover, 22(42.30%) of women and 30 (57.70%) of men tested positive for HRCT, which there was not a statistically significant association between the gender and HRCT result based on the results from the chi-square test ($p > 0.05$). The mean age of the patients with negative and positive of HRCT was 58.13 ± 18.26

and 58.12 ± 16.70 . Mann-Whitney test showed that there was not a statistically significant difference between the median of age in the two groups of HRCT result ($p > 0.05$). So that, 16 (30.80%) patients under the 50% lung involvement and 36 (69.20%) were over the 50% lung involvement (Table 1). Distribution dotplot of HRCT assessment of patients based on the HRCT result presented in figure 1. The mean W.B.C of the patients with negative and positive of HRCT was 16.90 ± 34.70 and 10.96 ± 20.36 . Mann-Whitney test showed that there was a statistically significant difference between the median of W.B.C in the two groups of HRCT result ($p < 0.05$) (Table 2). The mean O₂ Saturation of the patients with negative and positive of HRCT tests was 95.03 ± 4.49 and 93.21 ± 4.85 , respectively. Based on the results from Mann-Whitney, there was a statistically significant difference between the median of O₂ saturation in the two groups of HRCT result ($p < 0.05$). Out of a total of 52 positive cases, 23(44.20%) positive cases at the level of normal oxygen and 29(55.80%) positive cases occurred at the level of abnormal oxygen. Based on the results from chi-square test, there was a statistically significant association between level of O₂ saturation and HRCT results ($p < 0.05$). The mean ALP of the patients with negative and positive of HRCT tests was 544.67 ± 516.51 and 313.84 ± 227.36 , respectively. Results from the Mann-Whitney test showed that there was not a statistically significant difference between the median of ALP in the two groups of HRCT result ($p > 0.05$). In patients with normal ALP, 24(64.90%) of the cases had a positive HRCT and in abnormal ALP patients, 13(35.10%) of cases had a positive HRCT, which there was a statistically significant association between the level of ALP and HRCT result based on the results from the chi-square test ($p < 0.05$) (Table 3). Frequency distribution of past medical history (PMH) among patients with suspected COVID-19 under study presented in Table which 51 (61.40%) of patients had PMH.

Multiple logistic regression showed that ALP (abnormal vs. normal) and score of HRCT assessment variables had a significant effect on the positiveness of HRCT result ($P < 0.05$). So that, by adjusting the effect of other variables, the odds of positiveness of HRCT result with abnormal ALP was 0.04 times as than those with normal ALP and this difference is statistically significant ($P < 0.05$). Furthermore, by adjusting for the effects of other variables, for each unit increase in the score of HRCT assessment, the odds of positiveness of HRCT result of the patients were 5.17 times than those who did not have an increase ($P < 0.05$). But other variables had no significant effect on the positiveness of HRCT result ($P > 0.05$) (Table 5). The area under the ROC curve of the model was 0.96, which indicate the good predictive power of the model (Figure 2).

Discussion

COVID-19 infection was seen typically in middle-aged, man gender and elderly patients, and patients with other diseases were more susceptible to disease. A greater number of men was found than that of women, which was similar to previous studies (Wang et al., 2020, Jiang et al., 2020). women have a humoral immune response and greater innate than men and are thus less susceptible to many parasitic, fungal, bacterial, and viral diseases, while being more prone to developing a malignancies or autoimmune disease (Schurz et al., 2019). While these sex differences in rates of mortality may be due to sex-specific life styles (smoking, alcohol etc.)(Wrapp, Zarghami et al., 2019). Cough, fever, and dyspnea were main symptoms. abnormal lymphocyte, neutrophil, SGOT, and SGPT, increased CRP concentration and increased LDH concentration were the laboratory features of COVID-19 infection in present study. abnormal HRCT was seen in 88% of the patients as main indicator to evaluate the COVID-19 disease severity as other researchers(He et al., 2020, Zhang et al., 2020b).furthermore, WBC count, O₂ saturation, and were associated to lung involvement significantly, statically.

Other studies in clinical and laboratory findings

a metanalyses showed that the main clinical manifestations of COVID-19 were fever, cough, and dyspnea (Jiang et al., 2020). in a study with 208 patients, median age was 50.5 years, 51.4% of them were men and 48.6% were women. 7.7% of the patients had pulmonary diseases, 19.7% hypertension, and 6.3% diabetes. In our study, 26.5% of the patients had diabetes, hypertension and Asthma. Among all symptoms, 70.2% and 55.3% were belonged to fever and cough respectively. In compatible, 20.2% cases had decreased white blood cell count, and 29.3% cases had declined lymphocyte count. 74% of them had elevated CRP, and 11.1% had elevated LDH in the present study (Zhang et al., 2020b). In a retrospective cohort study, The mean age of

the patients were 59.5 years and 67% patients were male (Shi et al., 2020). In a study, of 138 hospitalized patients, the median age was 56 years and 54.3% were men. Common symptoms were included fever 98.6%, and dry cough 59.4%. Lymphopenia occurred in 70.3% patients. HRCT showed bilateral patchy shadows or ground glass opacity in the lungs of all patients (Wang et al., 2020). In a Meta analysis study, including a total of 50404 patients with 2019-nCoV infection, the incidence of fever was 90.9% , and cough was 70.8%, moreover the incidence of abnormal chest CT was 95.6% (Sun et al., 2020), abnormal HRCT in our study was 88%. In a study in Beijing of 262 patients, the median age of patients was 47.5 and 48.5% of them were men. The most common symptoms at the onset of illness were fever (82.1%), cough (45.8%), dyspnea (6.9%) (Tian et al., 2020) that compatible with our study. In the other study(Zhang et al., 2020a) of 140 hospitalized COVID-19 cases, a 1:1 ratio of men and women COVID-19 patients was found(50.7%), with a median age of 57.0 . Fever (91.7%), cough (75.0%) were the most common clinical manifestations, whereas hypertension (30.0%) and diabetes mellitus (12.1%) were the most common comorbidities (Zhang et al., 2020a). Bilateral patchy opacity or ground glass (89.6%) was the most common radiological finding. Lymphopenia (75.4%) and eosinopenia (52.9%) were seen in most cases. Eosinopenia with lymphopenia may be an indicator for diagnosis. Allergic diseases, asthma, and COPD are not risk factors for SARS-CoV-2 infection (Zhang et al., 2020a). The most common comorbidities in our study were hypertension, diabetes mellitus and asthma. Also, bilateral multilobar patchy ground glass opacities, bilateral multilobar patchy ground glass opacities and bilateral alveolar consolidations were the most common radiological findings in present study. Another study showed that of 1099 patients, the median age of the patients was 47 years; 41.9% of the patients were female. The common symptoms were fever and cough. Ground-glass opacity was the most common radiologic finding on chest CT (56.4%). 83.2% of the patients had lymphocytopenia. Patients often presented without fever, and many did not have abnormal radiologic findings(Guan et al., 2020). Ground-glass opacity in present study was higher common finding. Similar to our study, lymphocytopenia in COVID-19 patients was seen in the other studies(Surveillances, 2020, Diao et al., 2020). In a metha analysis, for 656 patients, fever 88.7%, cough 57.6% and dyspnea 45.6% were the most prevalent manifestations(Rodriguez-Morales et al., 2020). Of the 99 patients with 2019-nCoV pneumonia, The average age of the patients was 55*5 years, including 67 men and 32 women. 83% of the patients had fever, 82% cough, 31% shortness of breath, and 11% myalgia. According to imaging findings, 75% patients showed bilateral pneumonia, 14% patients showed multiple mottling and ground-glass opacity, and 1% patient had pneumothorax (Chen et al., 2020). Of the 10 cases, the average age was 56.5 years , 60% of the patients were males, Dry cough was the main symptom, followed by fever and fatigue. Chest computed tomography results were nonspecific, mainly with ground-glass attenuation and/or shadow images (Xia et al., 2020). Fever 72%, and cough 83% were common symptoms in a study. 33% of them had an abnormal chest radiograph finding or lung crepitations. Lymphopenia was present in 39% (Young et al., 2020). A total of 5700 patients were included with median age, 63 years, and 39.7% female. The most common comorbidities were hypertension 56.6%, and diabetes 33.8% (Richardson et al., 2020). In a study, The prevalence of asthma in patients with COVID-19 was 0.9% (Li et al., 2020). During the course of a study 21 COVID-19 positive patients were admitted in , Jaipur, 66.66% of the patients were men and 80.90% were less than 60 years of old. Almost 33.33% patients were asymptomatic and of those who were symptomatic, cough was seen in 85.71% that followed by myalgia (64.28%), fever (78.57%), and dyspnea (28.57%). 14.28 % of the cases had co morbidities in the form of diabetes mellitus, hypertension, hypothyroidism, or coronary artery disease. moreover, 52.38% of the patients had lymphopenia(Bhandari et al., 2020). These patterns in comorbidities and lymphopenia were seen in our study, too.

Other studies in HRCT findings

is an important component in the diagnostic procedure for patients with suspected COVID-19 infection. Chest CT has limited sensitivity and negative predictive value early after symptom onset, and has little weakness in diagnosis of COVID-19 combined to personal history, clinical symptoms, and initial laboratory findings, and may therefore serve as a standard method for diagnosis of COVID-19 based on its features and transformation rule, the limited number of RT- kits in some centers before initial RT- screening (Bernheim et al., 2020, Chen et al., 2020). Although 12% of patients were without abnormal lung changes on initial CT images in present study.

In a study, the most HRCT findings were bilateral parenchymal ground-glass opacities, without or with consolidation in the lung periphery. Especially, 75% patients with chest HRCT findings related to COVID-19 pneumonia had negative results of concurrent nucleic acid tests (He et al., 2020). Then, 21.70% of positive chest HRCT patients in present study had normal CRP. According to imaging examination in a study, 75% patients showed bilateral pneumonia, 14% patients showed multiple mottling and ground-glass opacity, and 1% patient had pneumothorax (Chen et al., 2020).

In a study, The CRP, ESR, and LDH presented significantly positive correlation with the pneumonia severity on CT. The highest temperature and the severity of opacifications assessed on initial CT were significantly related to the progression of opacifications on follow-up CT(Xiong et al., 2020). In present study, LDH had significantly positive correlation with HRCT. In a study, GGO was the most common manifestation of COVID-19 pneumonia, which could be followed by consolidation and fibrosis. Total CT score, GGO score and fibrosis score of male patients were significantly higher than female in the second week. Male patients had higher consolidation score and fibrosis score than female in the third week. Total CT score and GGO score had weak to moderate correlation with arterial blood gas indices (Shang et al., 2020). In our study, 42.30% of women and 57.70% of men had positive HRCT for COVID- a meta-analysis, 40 studies with 4183 COVID-19 patients, the rate of positive CT scan in COVID-19 patients was 94.5%. Bilateral lung involvement, GGO pulse consolidation or reticular, consolidation, reticular, presence of nodule findings and GGO, in CT scan of COVID-19 pneumonia patients were respectively estimated to be 64.9% , 49.2% , 30.3% , 17.0% ,16.6%, 94.5% . The lung lesions distribution in patients with COVID-19 was 70.0% peripheral, 3.9% central, and31.1% peripheral and central (Karimian and Azami, 2020). In a study, of 1014 patients, 59% had positive RT- results, and 88% had positive chest CT scans. The sensitivity of chest CT in suggesting COVID-19 based on positive RT- results was 97%. In patients with negative RT- results, 75% had positive chest CT findings; 48% were categorized as highly likely cases, with 33% as probable cases. 60% to 93% of cases had positive CT consistent with COVID-19 prior to the initial positive RT- results (Ai et al., 2020).

A total of 14 articles including 1115 patients, pure GGO 69%, consolidation 47% and “air bronchogram sign” 46% were more common than the atypical lesion of “crazy-paving pattern” 15%. while 67% of patients showed a predominant peripheral distribution (Wan et al., 2020). In a study, included 52% men, and the mean age was 49*5 years. The major pattern of abnormality observed was bilateral 79%, peripheral 54%, and GGO 65%. A weak relevance was between the fibrosis score and the value of PaO₂ and SpO₂(Dai et al., 2020). There was a statistically significant association between level of O₂ saturation and HRCT results in present study. In a study, with median age of 45 , 98% patients had evidence of abnormal CT compatible with viral pneumonia at baseline (Fang et al., 2020).

It suggested the critical importance to combine the two methods in the early stage of the disease to exclude the SARS-CoV-2 infection. These CT performances of COVID-19 were similar to previous studies. The O₂ saturation decreased in patients, which were in consistence with the alteration of indices in patients with lung involvement. the bilateral GGO was higher in the present study. Our results support the use of chest CT for screening for -19 for patients with clinical and laboratory features compatible with COVID-19 infection(Shi et al., 2020). Additionally, a positive relevance was found between the HRCT score, O₂ saturation, that was, a patient with higher CT score tended to have lower O₂ saturation.

Limitation

There were several limitations in this study. First, none of the patients underwent a lung biopsy or autopsy, because of the comparatively better outcomes of the patients in this study. Therefore, the HRCT findings of the lung could not be verified by histopathology. Finally, this was a study with initial HRCT images during hospitalization, mainly demonstrated the early pulmonary lesions in patients with COVID- further longitudinal research was needed to focus on the long-term follow-up, to provide dynamic HRCT evaluation for pulmonary lesions and to obtain the data of long-term pulmonary function changes.

Conclusion

In the present study, middle-aged, male gender and elderly patients, and patients with comorbidity were

more susceptible to the COVID-19 infection. W.B.C count, O₂ saturation, and ALP were related to lung involvement significantly. Cough, fever, and dyspnea were main symptoms(Zarghami et al., 2020). Abnormal HRCT was a main indicator to evaluate the COVID-19 disease. As a whole, clinical feature, blood laboratory findings, O₂ saturation and HRCT findings are critical factors in prognosis of COVID-19 infection.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Ethical approval

The current study was reviewed and approved by the Research Ethical Committee, XXXX (IR.XXXX.REC.1399.102) .

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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