Trauma Monthly 2021; 26(3): 152-156
10.30491/TM.2021.247870.1172

Trauma Monthly

Original Article

Asymptomatic COVID-19 infection in multiple trauma patients: incidence and implications

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Received September 12, 2020; **Accepted** May 26, 2021; **Online Published** May 26, 2021

Abstract

Background: Some studies show a chest CT scan to be superior to reverse transcription-polymerase chain reaction (RT-PCR) studies for diagnosis of COVID-19.
Objectives: This study was designed to assess the prevalence of COVID-19-related lung involvement in patients admitted to our trauma center.
Methods: In this retrospective study, data from a referral trauma center were reviewed from February 21, 2020, to April 10, 2020. All patients admitted to the hospital for whom a chest CT scan was performed for any reason during the study period were included. Trained physicians screened all CT scans for findings suggestive of COVID-19. Next, blinded radiologists selected CT scans with findings highly suggestive of COVID-19 involvement. The clinical course and outcome and the results of PCR for SARS-CoV-2 were recorded and assessed.
Results: A total of 4200 chest CT scans were reviewed. After multiple rounds of exclusion, 24 patients with highly- suggestive findings were reviewed. Only three patients developed COVID-19 symptoms during the course of admission. PCR results were positive in 22 patients (92.6%).
Conclusion: We recommend chest CT scans in trauma patients at a high risk of COVID-19 infection, as well as those requiring extensive surgical interventions. Also, a thorough review of the available CT scans before invasive procedures, preferably with the help of an expert radiologist, is highly recommended, even when the results of the COVID-19 laboratory tests are negative.

Keywords: COVID-19, SARS-CoV-2, Fractures, Multiple Trauma, Computed Tomography.

Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes the Coronavirus disease 2019 (COVID-19) first emerged in China at the end of 2019 and soon spread throughout the world.[1] Presentation of SARS-CoV-2 infection ranges from asymptomatic infection to mild pneumonia and severe disease with dyspnea to acute disease with respiratory failure, shock, or multiorgan dysfunction.[2]

As cases of COVID-19 increase globally, the knowledge around this virus is evolving. But so far, there are no reliable treatments on the close horizon to manage COVID-19 or a vaccine to prevent its spread. Also, clinicians face a significant challenge in dealing with complications related to this infection. Therefore, social distancing has been adopted globally to 'flatten the curve' of COVID-19 infection. Iran was hit hard with an early outbreak and a high initial rate of infection. Following the national lockdown orders, the rate of infection has reduced substantially, which has also led caused economic collateral damage. Countries worldwide have already started to loosen the social distancing rules, which may lead to the spread of infection.[3]

Trauma centers have a unique role in the healthcare system. The economic restart will increase the patient load of trauma centers. Combined with the anticipated increase in the incidence of COVID-19, trauma centers might be on the brink of an unexpected resurgence of COVID-19, which they are unlikely to be prepared for the crisis.

Chest CT scan is highly sensitive and specific in the diagnosis of COVID-19, even in asymptomatic cases. Various studies showed that a chest CT scan is superior to

reverse transcription-polymerase chain reaction (RT-PCR) test in the diagnosis of COVID-19, with the added advantage of being able to follow the progression of the disease objectively.[4,5] The sensitivity of chest CT in PCR-confirmed cases is 97% but has a lower specificity than PCR. Also, while a positive PCR will be observed in almost all patients during the disease process, the initial test might be negative. Chest CT is beneficial during this stage, where the lung findings are evident, but PCR is still not reactive.[5]

Objectives

Therefore, this study was designed to assess the prevalence of COVID-19-related lung involvement in patients admitted to a trauma center. Given the high prevalence of asymptomatic COVID-19 infections, we would encounter a high incidence of COVID-19-related chest CT scan changes in asymptomatic patients.

Materials and Methods

In a retrospective study, data from a regional referral trauma center (Taleghani hospital, Kermanshah University of Medical Sciences) from February 21, 2020, to April 10, 2020, were reviewed. Our center is the referral trauma center for a total population of one million. We surveyed all patients admitted to the emergency department with a diagnosis of multiple trauma. Inclusion criteria included patients admitted to the hospital, for whom a chest CT scan was performed during the study period for any reason. While admissions for all reasons were included, only multiple trauma patients are routinely evaluated with a chest CT scan, and therefore, there is a high probability of having orthopaedic injuries. Patients who were re-admitted and those with incomplete records were excluded. Also, for patients with >1 CT scans, only the first imaging after admission was reviewed. All data were accessed through the electronic health system, and CT scans were reviewed on the computer screen from the picture archiving and communicating system (PACS). A physician was trained to screen all CT scans, looking for COVID-19-related findings, extrapolated from the literature.[6-8]

This investigator was unaware of the clinical condition of the patients, as well as the status of COVID-19 infection. A form was filled for each CT scan (Appendix-1), and the presence of ≥1 findings suggestive of COVID-19 qualified the patient for the next round of readings.

Next, two experienced radiologists, also unaware of the clinical course and diagnosis of the patients, separately examined the CT scans from the previous round. In compliance with the national guidelines, the Iranian radiology society criteria for reporting COVID-19 imaging were used, which reports CT scans in three categories:[4] highly suggestive, inconsistent, and normal (Table-1).

The radiologists used a separate form to report their findings (Appendix-2), with details of the lobes involved and the patterns visible on CT scans.

The charts of the patients remaining after the second round of screening were extracted and thoroughly reviewed. Demographic data, presence or absence of clinical COVID-19 symptoms, the results of deep nasal swab polymerase chain reaction (PCR) for SARS-CoV-2, and the reason for admission, as well as the clinical course and outcome, were recorded. Descriptive statistics were used to report frequencies and means. All statistical analyses were performed using the IBM SPSS Statistics for Windows (Version 23.0, Armonk, NY, IBM Corp).

Table-1. Iranian radiology society preferred reporting of COVID-19 imaging studies.
Adapted from Radiologic management of COVID-19: preliminary experience of the Iranian Society of Radiology COVID-19 Consultant Group (ISRCC). Iranian Journal of Radiology, 2020.

Highly-suggestive findings	Inconsistent findings
Ground glass/consolidation opacities	Tree in bud opacities
Bilateral/multilobe involvement	Centrilobular distribution
Peripheral distribution	Peri-Broncho-vascular disruption
Round opacities	Predominantly nodular opacities
	Cavitation
	Lymphadenopathy
	Pleural effusion

Results

During the study period, 4200 patients underwent a chest CT scan at our institution. After the first round of readings, 320 studies (7.6%) were selected as having findings suggestive of COVID-19. After separate readings by two radiologists, 74 CT scans were selected. Next, patients having patterns with the highest specificity for COVID-19 were selected by consensus between the two radiologists. The last round yielded 24 records (Figure-1).

Of the 24 patients, 20 (83%) were male. The mean age was 37.6 years (SD 3.5). Sixteen patients were admitted following a car accident, five after a falling accident, and three with blunt trauma from fights.

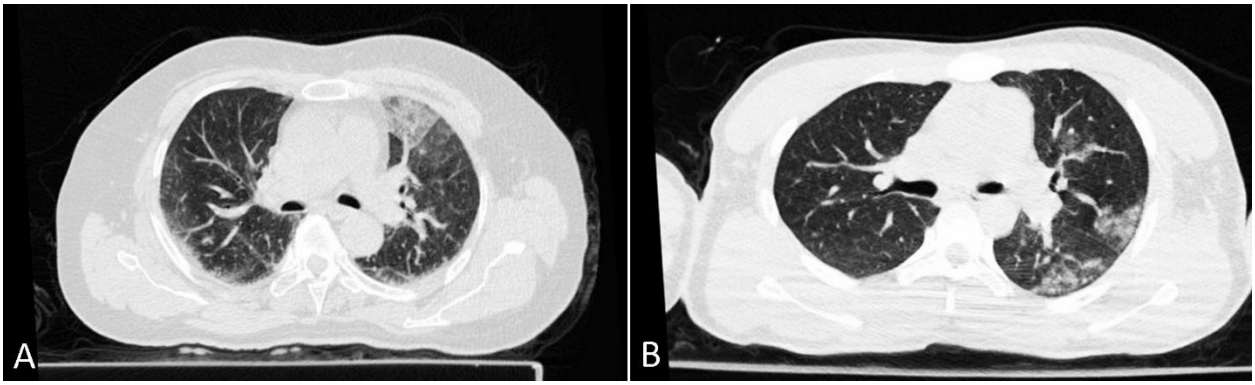

Figure-1. A 51-year-old patient with a both-bone forearm and proximal humeral fractures following a car accident. The patient had no respiratory symptoms, despite diffuse involvement of both lungs, as evident on the CT scan (A). Chest CT scan of an 18-year-old male admitted following a fall from a height, with bilateral calcaneal and lumbar spine fractures. The patient was also asymptomatic (B).

Sixteen patients (67%) had sustained a fracture or dislocation (Table-2). Three patients (12.5%) had respiratory symptoms compatible with COVID-19. The mean white blood cell count of the patients was 14,500 (range, 4,900-23,900, SD: 4,542.23) with a lymphocyte count of 2500.

Table-2. Orthopaedic injury patterns of the 24 patients with a highly suggestive CT scan pattern. Note that some patients had more than one injury.

Injury pattern	Number of patients
Upper extremity	
Scapular fracture	4
Humerus fracture (all locations)	3
Clavicle fracture	3
AC joint injury	2
Forearm both-bone fracture	2
Distal radius fracture	1
Lower extremity	
Tibiofibular fracture	3
Femoral shaft fracture	2
Calcaneal fracture	2
Proximal femoral fracture	1
Spinal injuries	
Lumbar spine fracture	2

One of the patients developed ARDS during the hospital stay and died following admission to the ICU. The remaining 23 patients were discharged following recovery from their initial injuries. All patients who came to the hospital due to trauma and required treatment underwent surgery and were discharged after the operation with no early complications.

All 24 patients had a rounded morphology pattern of ground-glass opacities on the chest CT scans, and four patients also had the crazy-paving pattern.

The lobes involved were left upper and lower lobes (each in 15 patients), right lower lobe (15 patients), right upper lobe (14 patients), and right middle lobe (9 patients). Eight patients had universal involvement of all lobes (33%). Five patients had unilateral involvement (3 on the right, 2 on the left). The results of PCR for SARS-CoV-2 were positive in 22 patients. When highly suggestive CT-scan findings were considered the diagnostic gold standard, a positive PCR had a sensitivity of 92.6%. Both patients with a negative PCR result were asymptomatic and had limited lobar involvement.

Discussion

Several countries have already started to ease the social distancing interim laws. The re-opening of the economy will

nevertheless result in the resurgence of COVID-19.[9] With neither a proven treatment nor a vaccine available; this may result in overloaded hospitals in a yet recuperating healthcare system. Trauma centers will be at the forefront of this crisis, as the trauma caseload will undoubtedly increase, and COVID-19 might dramatically affect the treatment and prognosis of traumatic injuries.[10]

In this study, we retrospectively reviewed the available CT scans of patients admitted in a 45-day period to determine the prevalence of highly suggestive findings of lung involvement due to COVID-19. Our findings are alarming, as we found 24 patients with lung involvement, most of which were multi-lobar. Only three patients were symptomatic on further review of the charts.

CT scan is highly specific in diagnosing of COVID-19.[4,5] Previous studies have reported a high sensitivity of up to 97% for chest CT scan, while the specificity is lower than PCR tests [5]. We found ground-glass opacities of round morphology to be the most common findings, similar to previous studies.[11] Some previous studies have shown that the sensitivity and specificity of CT findings are higher than those of PCR studies.[5] In this study, PCR had a sensitivity of 92.6% in patients with highly suggestive CT findings. It should be noted that due to the overload of the laboratory facilities at our institution at the beginning of the pandemic, the results of the PCR tests were reported at least 1.5 days after the request and were not available if the patients required an emergent surgical intervention.

A high rate of asymptomatic infection has been reported with COVID-19, and some studies have suggested that early screening of highly-suspected cases with CT scans may predict severe complications such as acute respiratory distress syndrome (ARDS).[12] At a minimum, isolation measures could be undertaken earlier, contact tracing is commenced in regions with such measures, and PCR studies rechecked if negative.[13] With the high infectivity rate of COVID-19, these steps are necessary to break the chain of infection.

Patients in trauma centers are likely to require surgical intervention during their hospital stay. Surgery in patients with COVID-19 has been shown to have a high complication rate, including ARDS, long ICU stay, and a high postoperative mortality rate.[14] A proportion of surgical interventions could be postponed with no minimal change in prognosis, including some orthopedic and reconstructive procedures. Therefore, during the current pandemic, proper screening and diagnosis of high-risk patients are absolutely essential to reduce mortality and improve prognosis. A thorough review of the available CT scans before invasive procedures, preferably with the help of an expert radiologist, is highly recommended, even when the results of the COVID-19 laboratory tests are negative 002E

This study has several limitations, including those inherent to a retrospective chart review. We assessed COVID-19 PCR or antibody tests for the intermediately suggestive findings due to a high rate of inconclusive tests at the beginning of the study period. Also, some patients might have become symptomatic after discharge. We also did not include the less-suggestive finding to increase the specificity of our imaging findings.

Conclusions

In conclusion, in a retrospective review of 4200 chest CT scans of patients at a trauma center, we found 24 patients with highly suggestive findings of COVID-19, which all of them except three being asymptomatic. The sensitivity of PCR was 92% in the presence of highly suggestive CT findings. We suggest having a lower threshold for ordering chest CT scans in trauma patients at a high risk of COVID-19 infection, and those requiring extensive surgical interventions.

Acknowledgments

The authors would like to thank Javad Veisi, M.D, Mehdi Naderi, Ph.D., from the Clinical Research Development Center, for their cooperation and assistance throughout the study.

Authors' Contribution

SSK, FN, RM, MSM, MK, and SM contributed to the conception of the work, data collection, and reporting the radiographs. SSK, FN, MK, and SM contributed to the statistical analysis. SSK, RM, MG, and AB contributed to writing the first draft of the manuscript and the revisions. SSK, FN, RM, MSM, MK, SM, MG, and SB have read and approved the final version of the manuscript and take full responsibility for the accuracy and integrity of the work.

Conflict of Interests

Authors declare no conflict of interests.

Funding/Support

No funding was received for this study.

Ethics approval and consent to participate

Ethical approval was obtained by the ethics committee of the Kermanshah University of Medical Sciences. All consents to participate were obtained from the participants.

Consent for publication

Written patient consent was obtained for publication of all aspects of the case, including personal and clinical details and images from the patient.

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Appendix-1. Form 1 – this form was used for the primary screening by the trained physician

CT Features Analysis Patients			
Pattern		**YES**	**NO**
Ground Glass Opacity (GGO)			
Multilobe involvement			
Bilateral distribution			
Posterior Involvement			
GGO location (peripheral)			
Subsegmental vessel enlargement (> 3 mm)			
Consolidation	**Subsegmental**		
	Segmental		
Lymphadenopathy			
Bronchiectasis			
Air Bronchogram			
Pulmonary nodules surrounded by GGO			
Interlobular Septal thickening			
Halo sign			
Pericardial Effusion			
Pleural effusion			
Bronchial wall thickening			
Cavitation			
Pulmonary artery diameter ration			

Appendix-2. Form 2 – this form was filled by the two expert radiologists reviewing the patients from the last round

which lobes involved	
lobe involvement	Right upper lobe
	Right middle lobe
	Right lower lobe
	Left upper lobe
	Left lower lobe
GGO pattern	Crazy Paving
	Rounded morphology
	Linear opacities