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Original Article

Comparison of chest CT scan findings between COVID-19 and pulmonary contusion in trauma patients based on RSNA criteria: Established novel criteria for trauma victims

Hossein Abdolrahimzadeh Fard [a], Salahaddin Mahmudi-Azer [a], Qusay Abdulzahraa Yaqoob [b], Golnar Sabetian [c], Pooya Iranpour [d], Zahra Shayan [e], Shahram Bolandparvaz [a], Hamid Reza Abbasi [a], Shiva Aminnia [f], Maryam Salimi [f], Mohammad Mehdi Mahmoudi [a], Shahram Paydar [a], Roham Borazjani [a], Ali Taheri Akerdi [a], Masome Zare [g], Leila Shayan [a], Mohammadreza Sasani [d, *]

[a] Trauma Research Center, Shahid Rajaee (Emtiaz) Trauma Hospital, Shiraz University of Medical Sciences, Shiraz, Iran
[b] Department of General Surgery, Kufa University of Medical Sciences, Najaf, Iraq
[c] Department of Intensive Care Medicine, Trauma Research Center, Shahid Rajaee (Emtiaz) Hospital, Shiraz University of Medical Sciences, Shiraz, Iran
[d] Department of Radiology, Medical Imaging Research Center, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
[e] Department of Biostatistics, Trauma Research Center, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
[f] Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran
[g] Trauma Intensive Care Unit, Trauma Research Center, Shahid Rajaee (Emtiaz) Trauma Hospital, Shiraz University of Medical Sciences, Shiraz, Iran

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ABSTRACT

Propose: In this study, we re-assessed the criteria defined by the radiological society of North America (RSNA) to determine novel radiological findings helping the physicians differentiating COVID-19 from pulmonary contusion.

Methods: All trauma patients with blunt chest wall trauma and subsequent pulmonary contusion, COVID-19-related signs and symptoms before the trauma were enrolled in this retrospective study from February to May 2020. Included patients (Group P) were then classified into two groups based on polymerase chain reaction tests (Group Pa for positive patients and Pb for negative ones). Moreover, 44 patients from the pre-pandemic period (Group PP) were enrolled. They were matched to Group P regarding age, sex, and trauma-related scores. Two radiologists blindly reviewed the CT images of all enrolled patients according to criteria defined by the RSNA criteria. The radiological findings were compared between Group P and Group PP; statistically significant ones were re-evaluated between Group Pa and Group Pb thereafter. Finally, the sensitivity and specificity of each significant findings were calculated. The Chi-square test was used to compare the radiological findings between Group P and Group PP.

Results: In the Group PP, 73.7% of all ground-glass opacities (GGOs) and 80% of all multiple bilateral GGOs were detected ($p < 0.001$ and $p = 0.25$, respectively). Single bilateral GGOs were only seen among the Group PP. The Chi-square tests showed that the prevalence of diffused GGOs, multiple unilateral GGOs, multiple consolidations, and multiple bilateral consolidations were significantly higher in the Group P ($p = 0.001$, 0.01, 0.003, and 0.003, respectively). However, GGOs with irregular borders and single consolidations were more significant among the Group PP ($p = 0.01$ and 0.003, respectively). Of note, reticular distortions and subpleural spares were exclusively detected in the Group PP.

Conclusion: We concluded that the criteria set by RSNA for the diagnosis of COVID-19 are not appropriate in trauma patients. The clinical signs and symptoms are not always useful either. The presence of multiple unilateral GGOs, diffused GGOs, and multiple bilateral consolidations favor COVID-19 with 88%, 97.62%, and 77.7% diagnostic accuracy.

Introduction

The rapid spread of 2019-nCoV viruses and the subsequent pandemic make COVID-19 a global challenge for health care systems.[1,2] Prompt diagnosis and strict isolation of affected patients

* Corresponding author.
E-mail address: mohammadrezasasaani@gmail.com (M. Sasani).
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are of significant importance in preventing the further spread of the disease. Therefore, conducting effective screening systems for early detection and isolation is the first step to achieving this goal.[3]

Patients with positive reverse transcription-polymerase chain reaction (RT-PCR) tests were considered definite cases regardless of COVID-19-related signs and symptoms. Moreover, asymptomatic carriers can act as the super spreaders worsening the pandemic.[4] Inadequate sensitivity and time-consuming RT-PCR tests, and the possibility of false-negative results are the present pitfalls that healthcare workers face. Therefore, other paraclinical methods should be used to increase the overall diagnostic accuracy.

The radiological society of North America (RSNA) provided a reference to detect COVID-19-induced lung injuries based on CT images, as shown in Table 1.[5] Although not statistically significant, the higher diagnostic sensitivity, detecting asymptomatic patients, and faster access to results are some of the advantages discussed in various studies comparing the chest CT images and RT-PCR tests.[6,7] Despite the widespread availability of CT images, it is not recommended as an initial screening method due to its low specificity and negative predictive value. Hence, CT images are efficient in association with other diagnostic tools.[5,8]

Allocating special medical centers for hospitalization and treating symptomatic patients constrain the national resources during the COVID-19 pandemic.[9] Due to contact with infected or suspected patients in these centers, all the necessary protocols need to be observed and adequate personal protective equipment need to be used in order to prevent the infection in medical staff. However, it is hard to carry out these measures in centers with limited resources. This increases the risk of infection among medical staff in these centers, especially in department where patients requiring emergency treatment, such as trauma patients. Therefore, in trauma centers, it is necessary to create screening systems for patients, especially asymptomatic carriers, while performing the essential treatments for trauma. These screening systems should be based on the specific characteristics of trauma patients. Given that most studies on COVID-19 have been performed in non-trauma patients, the same results should be evaluated by other studies in trauma patients because trauma as an independent factor can have a distorting effect on COVID-19 disease findings.

Therefore, this single-center, retrospective study aimed to define the specific findings in CT images of trauma patients helping physicians to differentiate COVID-19 and pulmonary contusion. The CT images were interpreted based on RSNA criteria, as summarized in Table 1.

Methods

Study design

In this retrospective, cross-sectional study, we evaluated the CT images of patients referred to Rajaee Hospital as the biggest referral trauma center in Southern Iran from February to May 2020. Inclusion criteria were all of the following: pulmonary contusion, blunt chest wall trauma, and COVID-19-related clinical features before the chest wall trauma. Individuals with penetrating chest wall trauma, previous history of underlying pulmonary diseases, and the absence of chest CT images or RT-PCR were excluded.

Our previous study (Fig. 1) showed that the sensitivity and specificity of RSNA criteria were not suitable for diagnosing COVID-19 in trauma patients.[10] The recent survey was designed to find appropriate radiological diagnostic features differentiating between COVID-19 and pulmonary contusion (Fig. 2). Included individuals during the pandemic (Group P) were categorized based on the RT-PCR results into two subgroups: the definite, positive RT-PCR group (Group Pa) and the non-definite group (Group Pb) in whom RT-PCR tests were negative. However, we could not rule out COVID-19 in the Pb group due to the false-negative results. Another group was selected during the pre-pandemic period (Group PP) as definite pulmonary contusion cases without COVID-19-related radiological findings. This group was matched to Group P based on age, sex, and trauma-related parameters.

Patients' selection

The coexistence of pulmonary contusion and COVID-19 in the patients with respiratory symptoms before the occurrence of blunt chest trauma and the presence of false-negative results of RT-PCR tests make it challenging to differentiate radiological findings of COVID-19 and pulmonary contusion. Therefore, in the recent survey, we aimed to compare these findings in patients with definite lung contusion (Group PP) to that of patients during pandemic (Group P) to eliminate the risk of concurrent infection as a confounding factor.

At first, all RSNA criteria and the trauma-related radiological findings were compared between the two main groups (Group P and Group PP). Then, each statistically significant findings were assessed in two subgroups (Group Pa and Group Pb).

Chest CT protocol

After obtaining written informed consent from the patients or their next of kin, as a routine protocol in managing chest wall

Table 1
RSNA criteria for COVID-19 pneumonia.

COVID-19 RSNA classification	Rationale	Chest CT scan findings
Typical appearance	Commonly reported imaging feature of greater specificity for COVID-19	Peripheral, bilateral GGO OR Round, multifocal GGO +/− Consolidation or crazy paving sign Reverse halo sign
Indeterminate feature	Nonspecific image for COVID-19	Absence of typical feature AND Multifocal, diffuse, perihilar or unilateral GGO+/− Non-round, non-peripheral consolidation Few very small GGO, non-round and non-peripheral distribution
Atypical appearance	Uncommon or not reported features of COVID-19	Absence of typical and atypical features AND Single lobar or segmental consolidation Discrete small nodules Lung cavitation Smooth interlobular septal thickening with pleural effusion

RSNA: the radiological society of North America; GGO: ground-glass opacity.
+/−: with or without.

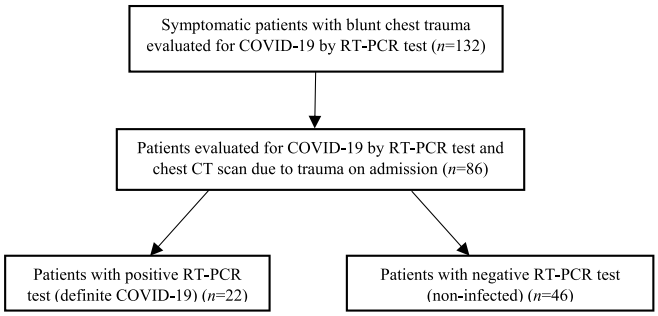

Fig. 1. Flowchart of patients' selection in our previous study. RT-PCR: reverse transcription-polymerase chain reaction.

trauma, all patients underwent unenhanced CT with a 16-slice CT scanner (CT emotion 16, Siemens Healthcare, Erlangen, Germany). Given the probability of COVID-19, all necessary protective measures have been taken according to the Iranian Ministry of Health and Medical Education guidelines.[11]

Image analysis

Two board-certified radiologists (MRS and PI), blind to the RT-PCR results and patients' allocation, reported all CT scans by consensus. Comparison of consolidations and ground-glass opacities (GGOs) was performed concerning the number (single, multiple), side of lesions (unilateral, bilateral), lung intra-lobe distribution (peripheral, central, diffused), and shape (irregular margin, round, different margin).

Statistical analysis

Collected data were analyzed using the Statistical Package for Social Sciences, version 16.0 (SPSS Inc., Chicago, IL, USA). Quantitative variables were presented as mean ± standard deviation, and categorical ones were shown as frequencies (numbers and percentages). The comparison between the two groups was performed using the Chi-square test or the Fisher exact test. Also, sensitivity and specificity have been calculated to determine the diagnostic accuracy of the different protocols. The $p < 0.05$ was considered statistically significant.

Results

This retrospective study was conducted between February and May 2020 at the largest referral trauma center in Southern Iran. Based on our inclusion and exclusion criteria, 16 positive RT-PCR patients were placed in the Group Pa, and 17 negative RT-PCR patients who were matched to the Group Pa regarding age, sex, and trauma-related scores were included in the Group Pb. Moreover, 49 cases were selected before the COVID-19 pandemic (Group PP) who were matched to the Group P in terms of age, sex, and trauma-related scores (Fig. 2). Statistical analysis between the two main groups and the subgroups did not show significant differences in age, sex, trauma-related scores as confounding factors (Table 2.). Besides, all patients with underlying diseases were excluded to avoid further complexity.

In the Group P, 21.4% of images had typical features of RSNA criteria, 32.1% were indeterminate, 28.6% had atypical features, and 17.9% had normal CT images. In the Group PP, 41.5%, 41.5%, 9.8%, and 7.2% of all CT images had typical, indeterminate, atypical, and normal features of the RSNA criteria, respectively. However, there were no statistically significant differences between the two main groups ($p = 0.06$). In the Group PP (as definitive lung contusion patients), 83% had typical and indeterminate manifestations based on RSNA classification before the 2019-nCoV virus exist (Fig. 3A, B and D). By eliminating all confounding factors, this evaluation

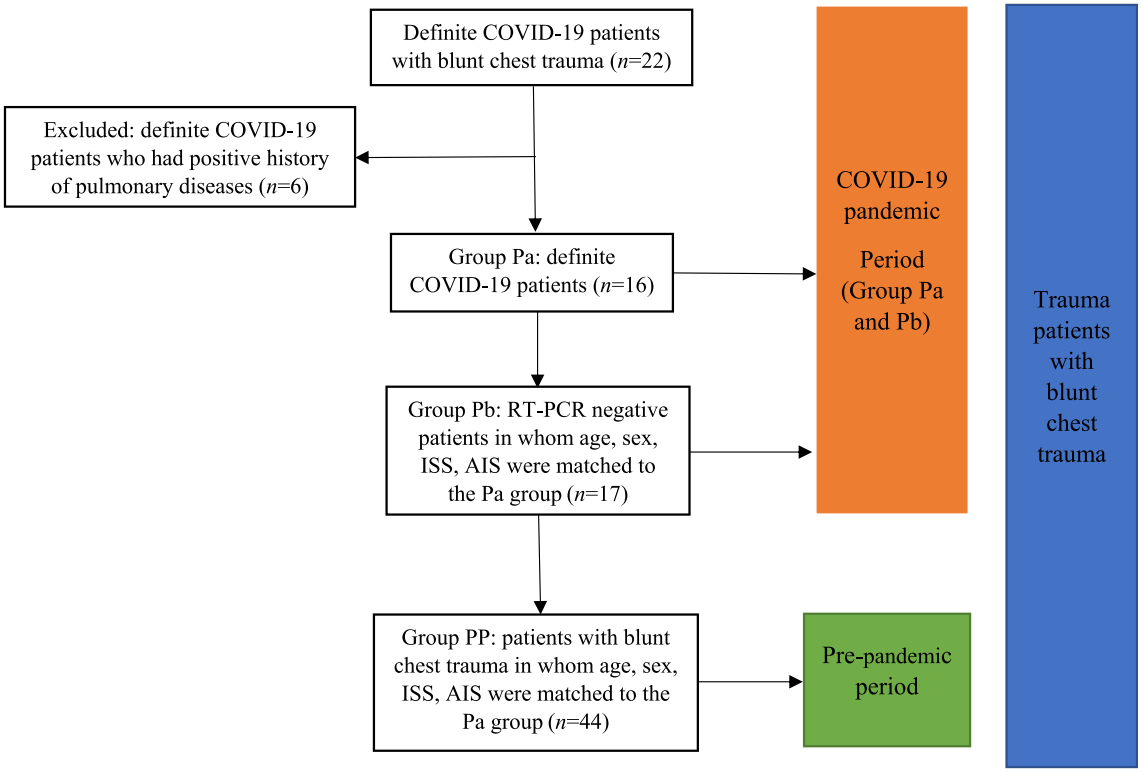

Fig. 2. Following pathway for patients' selection of this study. Pa: positive RT-PCR group; Pb: negative RT-PCR group; RT-PCR: reverse transcription-polymerase chain reaction; Group PP: pre-pandemic patients; ISS: injury severity score; AIS: abbreviated injury scale.

Table 2
Comparison of age, sex, trauma score between pandemic and pre-pandemic groups.

Variables	Pandemic period				Group PP	*p* value
	Group Pa	Group Pb	*p* value	Overall		
AIS, mean (SD)						
Head	1.11 (1.9)	2 (2.2)	0.22	1.5 (2.1)	1.49 (2.0)	0.9
Face	0.59 (1.0)	5 (1.1)	0.93	0.51 (1.0)	0.42 (0.9)	0.69
Thorax	1.23 (1.3)	1.56 (1.5)	0.5	1.39 (1.4)	1.42 (1.3)	0.9
Abdomen	0.11 (0.5)	0 (0)	0.34	0.06 (0.3)	0.04 (0.3)	0.77
Extremity	0.76 (1.3)	0.81 (1.1)	0.9	0.78 (1.2)	0.93 (1.2)	0.58
Extra	1 (0.0)	0.93 (0.3)	0.3	0.97 (0.2)	0.98 (0.1)	0.77
ISS, mean (SD)	12.7 (9.6)	17 (10.5)	0.18	14.5 (10.2)	14.3 (9.1)	0.92
Age (years), mean (SD)	32.4 (12.4)	33.06 (15.7)	0.89	32.7 (13.9)	34.2 (15.5)	0.61
Gender, *n* (%)						
Male	16 (100.0)	13 (76.5)		29 (87.9)	45 (91.8)	0.23
Female	0 (0)	4 (23.5)		4 (12.1)	4 (8.2)	0.22

AIS: abbreviated injury scale; SD: standard deviation; Pa: positive RT-PCR group; Pb: negative RT-PCR group; Group PP: pre-pandemic patients; ISS: injury severity score.

found that RSNA criteria are not suitable for differentiation of lung contusion from COVID-19 in the trauma population.

Therefore, each criterion was evaluated between Group P and Group PP to investigate the appropriate criteria differentiating between COVID-19 and pulmonary contusion. Besides, each statistically significant parameter was then assessed between the two subgroups of the pandemic period (Group Pa and Group Pb).

Evaluation of RSNA criteria revealed that GGO is the most common finding in both main groups (71.3%), of which 73.7% were in the definite lung contusion group ($p < 0.001$). Therefore, the existence of GGO as the most common criteria in the diagnosis of COVID-19 in non-trauma patients is more common in the definitive lung contusion group (Group PP). Although the evaluation of the overall GGO distribution (single bilateral, single unilateral, etc.) showed a significant difference ($p = 0.024$), the single and multiple GGO ($p = 0.12$), as well as whether they were unilateral or bilateral ($p = 0.53$), were not statistically significant between the two main groups (Group P and Group PP). Multiple bilateral GGO is the most common type in both main traumatic groups (52.6%). Although 80% of them are in the definitive lung contusion group (Group PP), but there was no significant difference between the two main groups ($p = 0.25$). Single bilateral GGO accounts for 7% of all lesions and can only be seen in the definitive lung contusion group (Group PP) ($p = 0.56$).

In Table 3, diffused GGO and multiple unilateral GGO are suggestive features for COVID-19, while irregular margins GGO is a representative feature for lung contusion. The existence of consolidation was only seen in 34.1% of the total patients in both main groups, of which 60.7% were in the Group PP (Fig. 3C1). However, there was no statistically significant difference in the consolidation between the two main groups ($p = 0.89$). However, if consolidation existed, there was a statistically significant difference in the number and side of pleural cavity involvement between the two main groups ($p = 0.007$).

The overall prevalence of consolidation was lower than that of GGO, and our results showed that multiple unilateral consolidations were suggestive features for lung contusion. In contrast, multiple bilateral lesions were associated with COVID-19.

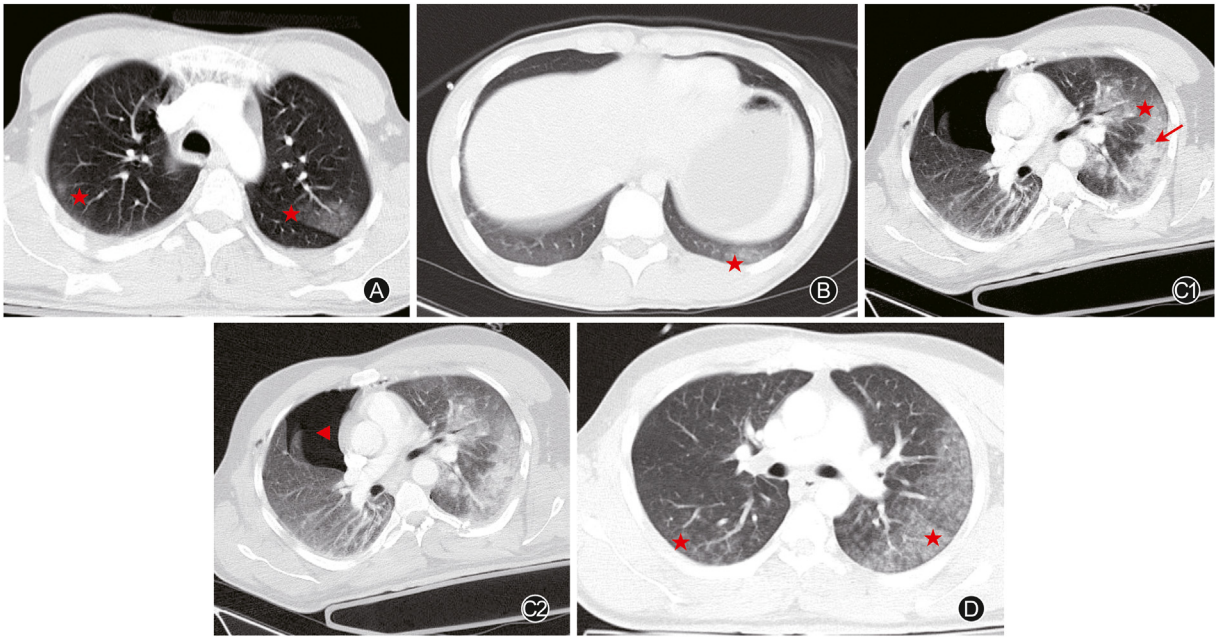

Fig. 3. Axial CT images of the chest in patients with pulmonary contusion before the pandemic of COVID-19: (A) Showed the bilateral area of ground-glass opacities (GGOs) in the left upper lobe and a smaller one in the right upper lobe (stars); (B) Showed an area of GGO in the left lower lobe (star); (C1) Lung window, demonstrated area of GGO in the left lung (star) with a small area of consolidation (arrow) and adjacent rib fracture, while (C2) the bone window of the same person, showed right side pneumothorax (arrow head); (D) Showed bilateral GGO in another patient with pulmonary contusion before the COVID-19 emergence.

Table 3
Differences of RSNA classification features between pandemic and pre-pandemic period.

RSNA findings	Group PP (%)	Group P (%)	*p* value[a]
Consolidation			
Number and location			
Single	86.7	13.3	0.003
Multiple	30.8	69.2	0.003
Unilateral	77.8	22.2	0.24
Bi-lateral	55.6	47.4	0.24
Single unilateral	77.8	22.2	0.24
Multiple unilateral	100	0	0.05
Multiple bilateral	30.8	69.2	0.003
Distribution			
Peripheral	64	36	0.41
Central	50	50	
Diffused	0	100	
Shape & margin			
Irregular margin	54.5	45.5	
Round shape	100	0	0.25
Different margin	66.7	33.3	
GGO			
Number and location			
Single	60.9	39.1	0.06
Multiple	82.4	17.6	0.06
Unilateral	80	20	0.32
Bilateral	70.3	29.7	0.32
Single unilateral	75	25	0.58
Single bilateral	100	0	0.56
Multiple unilateral	28.6	71.4	0.01
Multiple bilateral	80	20	0.2
Distribution			
Peripheral	80	20	0.09
Central	83.3	16.7	0.32
Diffused	0	100	0.001
Shape & margin			
Irregular margin	80.9	19.1	0.01
Round shape	40	60	0.1
Different margin	50	50	0.28
Reticular distortion	100	0	0.001
Sub plural spare	91.7	8.3	0.01

RSNA: radiological society of North America; GGO: ground-glass opacity; Pa: positive RT-PCR group; Pb: negative RT-PCR group; PP: pre-pandemic patients.
[a] Chi-square tests.

Other radiological findings showed that 15.9% of all trauma patients had reticular distortion, and this feature existed only in the Group PP ($p = 0.001$). Also, the subpleural spare has been seen in only 14.6% of patients, of which 91.7% are in the definitive lung contusion group ($p = 0.015$). Evaluation of trauma-related lesions showed the prevalence of rib fracture and pneumothorax were not different between the two groups, but hemothorax was statistically more common in the Group P ($p = 0.02$).

The subgroup analysis revealed that the prevalence of GGO with irregular margins was significantly higher in PCR-positive cases during the pandemic period (Table 4). Of note, few patients had subpleural spare, and none showed reticular distortion in CT images during the pandemic; therefore, their results were not shown in Table 4.

Table 4
Differences between RSNA radiological findings in two subgroups during the pandemic.

RSNA findings	Group Pa (%)	Group Pb (%)	*p* value
Consolidation			
Single	0	100	0.49
Multiple	44.4	55.6	0.49
Multiple bilateral	44.4	55.6	0.49
GGO			
Multiple unilateral	20	80	0.6
Irregular margin	80.9	19.1	0.01

Note: Only few patients had subpleural spare, and none of them had reticular distortion during the pandemic period. Therefore,these radiological findings were not shown in this table.
RSNA: radiological society of North America; Pa: positive RT-PCR group; Pb: negative RT-PCR group; GGO: ground-glass opacity.

The recent survey showed that single consolidation, reticular distortion, subpleural spare, and GGOs with irregular margins were suggestive radiological findings for the lung contusion; meanwhile, diffused distributed GGOs, multiple bilateral consolidations, multiple bilateral GGOs, and multiple consolidations were suggestive findings for COVID-19.

Finally, the Group Pa was considered as patients with concomitant COVID-19 and pulmonary contusion. Also, the Group PP was classified as non-infected patients with an isolated lung contusion.

Then sensitivity, specificity, positive and negative predictive value, the accuracy of each identified finding in the diagnosis of lung contusion, and COVID-19 were evaluated (Table 5). The results of this comparison provided diagnostic criteria for CT scans in trauma patients (Table 6).

Discussion

Pulmonary contusion is the most common sequels of blunt chest wall injuries (30%–75%) and is the major cause of mortality among all vehicle occupants in traffic accidents.[12] Clinical presentations vary; mild pulmonary contusion may be thoroughly asymptomatic, although more severe cases may cause pain, hemoptysis, hypoxia, cyanosis, dyspnea, and bronchorrhea.[13–16] Patients are usually asymptomatic early after insult, however, signs and symptoms may develop during the following hours.[17]

Several methods were occupied to diagnose and assess the severity of pulmonary contusion, of which chest CT images are the most sensitive. CT images can detect pulmonary contusion immediately after the insults when the clinical manifestations do not yet develop. However, these images lack specificity when they occurred concomitantly with viral pneumonia, especially COVID-19.[18]

To the best of our knowledge, few studies are available discussing the similarities and differences between COVID-19 and pulmonary contusion. Six of these surveys were case reports that exclusively showed some similarities, although they did not conduct proper criteria to differentiate these two entities.[19–24] Five out of six case reports had pulmonary contusions, and their CT images showed bilateral multifocal lesions. Based on our results, we concluded that the prevalence of bilateral lung involvement is higher in pure pulmonary contusion, although it was not statistically significant. Typically, a pulmonary contusion is a focal GGO or consolidation adjacent to the trauma sites; however, the trauma-induced inflammatory processes and countercoup phenomenon are believed to participate in bilateral or multifocal involvement. These mechanisms make the differentiation between COVID-19 and pulmonary contusion a challenge.[16,25] Two papers were letters to the editors.[25,26] One case series conducted by Wang et al.[27] showed 2 patients with concomitant COVID-19 and pulmonary contusion. Their CT images had plaque-like shadows in the lower lobes and GGOs near these lesions. Twenty-seven cases had pure pulmonary contusion with increased lung markings and subsegmental consolidation. None of these 27 cases had GGOs, which is inconsistent with our recent study.

Patients with pulmonary contusion, except the asymptomatic ones, usually complain of pain, dyspnea, hemoptysis, tachypnea with shallow breathing. These symptoms are present in patients with COVID-19 to some extent. Local tenderness, paradoxical movement of the chest wall, seat belt sign, and deformity are suggestive of pulmonary contusion[28,29]; however, they could not preclude the concomitant COVID-19. Associated injuries such as hemothorax, bilateral pleural effusion, and pneumothorax are

Table 5
Evaluation of valuable findings for the diagnosis of lung contusion and COVID-19, (%).

Radiological features	Sensitivity	Specificity	PPV	NPV	Accuracy
Lung contusion					
Reticular distortion	32	100	100	16.66	40.48
Sub plural spare	27	100	100	15.62	14.28
Single consolidation	71.4	100	100	50	77.7
Irregular margin GGO	91.8	60	79.4	50	88.08
COVID-19					
Multiple unilateral GGO	20	97.2	50	90	88
Diffused GGO	80	100	100	97.3	97.62
Multiple consolidations	100	71	50	100	77.7
Multiple bilateral consolidations	100	71	50	100	77.7

PPV: positive predictive value; NPV: negative predictive value; GGO: ground-glass opacity.

Table 6
Novel classification of chest CT scan findings for COVID-19 in trauma patients.

Classification	Rationale	Chest CT scan findings
Typical	High specificity & sensitivity for COVID-19	Multiple unilateral, diffused distribution GGO OR Multiple, bilateral Consolidation AND No evidence of non-conforming findings
Unknown	Need more evaluation for COVID-19	Not classified in typical or non-conforming groups OR Mixed evidence of typical OR Non-conforming finding
Non-conforming	High specificity & sensitivity for lung contusion	Irregular margin GGO +/− Single consolidation +/− Reticular distortion OR Sub plural spare

GGO: ground-glass opacity.
+/−: with or without.

characteristic of pulmonary contusions (Fig. 3. C2). However, Kong et al.[30] and Aydın et al.[31] reported a COVID-19 patient complicated by pneumomediastinum and spontaneous pneumothorax, respectively. Besides, our previous study showed that COVID-19 might contribute to increase pulmonary fragility and subsequent pneumothorax and hemothorax.[10] As mentioned before, during the COVID-19 pandemic, it seems impossible to differentiate COVID-19 from pulmonary contusion in patients with concomitant respiratory symptoms and blunt chest wall trauma. In addition, the history taking is disturbed in unconscious patients, and the physicians are unable to distinguish whether the victims had a history of respiratory signs and symptoms before the trauma.

Based on radiological findings, GGOs with irregular margins and single consolidation are highly suggestive of pulmonary contusion with a diagnostic accuracy of 88.08% and 77.77%, respectively. On the other hand, diffused and multiple unilateral GGO had the best diagnostic accuracies for COVID-19 diagnosis (97.62% and 88%, respectively).

Our study had some limitations, further research with a larger sample size conducting in multiple centers is needed to eliminate confounding factors and assess our results. Moreover, it is better to use a CT scan as a part of a scoring system for trauma patients due to the previously mentioned diagnostic limitations.

The recent study showed that the RSNA criteria are not sufficient to diagnose COVID-19 in trauma patients and the physicians need separate diagnostic criteria for trauma victims as a specific population. Based on RSNA criteria for non-traumatic patients, the peripheral and bilateral GGOs or multifocal GGOs are typical radiological features in COVID-19 patients[5]; however, we showed the prevalence of these findings was higher in pure pulmonary contusion (Group PP). According to the results of this study, irregular margin GGO, single consolidation, and reticular distortion had 88.08%, 77.70%, and 40.48% diagnostic accuracy in detecting contusion in patients with pulmonary contusion concomitant COVID-19 infections.

We think that our specific, newly introduced radiological criteria, along with other clinical findings, can effectively differentiate COVID-19 and pulmonary contusion leading to better resource management and reduce the risk of disease transmission, especially in the centers with resource constraints.

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Nil.

Ethical statement

The institutional review board has reviewed this study, and the Ethics Committee of Shiraz University of Medical Sciences has approved the concept and methods used in the current manuscript. All CT images were extracted from our database, anonymized, and reviewed by radiologists blindly.

Declaration of competing interest

None.

Author contributions

Hossein Abdolrahimzadeh Fard and Salahaddin Mahmudi-Azer: conceptualization, designed the study, contributed data gathering, writing original draft, contributed to the editing the final version of the manuscript.

Qusay Abdulzahraa Yaqoob: writing original draft, data analysis, contributed to the editing the final version of the manuscript.

Golnar Sabetian and Roham Borazjani: conceptualization, writing original draft, design data analysis, contributed to the editing the final version of the manuscript.

Pooya Iranpour: study design, data gathering, contributed to the editing the final version of the manuscript.

Zahra Shayan and Leila Shayan: data analysis, writing original draft, contributed to the editing the final version of the manuscript.

Shahram Boland Parvaz, Hamid Reza Abbassi and Shiva Aminnia: data gathering, study design, data analysis, contributed to the editing the final version of the manuscript.

Maryam Salimi, Mohammad Mehdi Mahmoudi, Ali Taheri Akerdi, and Masome Zare: data gathering, data interpretation, investigation, contributed to the editing the final version of the manuscript.

Mohammadreza Sasani and Shahram Paydar: conceptualization, designed the study, supervised the study process, data gathering, edit the final version of the manuscript.

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