Trauma and COVID-19: Clinical and Paraclinical similarities between Trauma Patients with Positive and Negative PCR Tests

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ABSTRACT

Objective: To compare clinical and paraclinical similarities between trauma patients with positive RT-PCR tests (PCR+ve) and the RT-PCR negative ones (PCR -ve).
Methods: This a case-control study, where cases had a PCR+ve and controls had a negative result. Two groups were compared regarding (para) clinical values. Multivariable binary logistic regression analysis investigated the variables predicting COVID-19 and the mortality rate.
Results: Both groups were similar regarding the clinical findings and comorbidities ($p>0.05$). PCR+ve group had lower lymphocyte count (1.41 [1.45] vs. 1.66 [1.61], $p=0.030$), CPK level (411 [928.75] vs. 778 [1946.5]. $p=0.006$) and CRP level (17 [42.5] vs. 24 [50.75], $p=0.004$). However, none of these findings were significant in the multivariable analysis. Finally, PCR+ve group had increased odds of death (OR=2.88; 95% CI=1.22-7.41).
Conclusion: Unlike our primary hypothesis, the study failed to mark any significant (para) clinical features guiding us to detect COVID-19 earlier in trauma patients. Moreover, the PCR+ve group is at increased mortality risk. A larger, multicentric prospective study should be designed to address this issue.

Keywords: Trauma; COVID-19; Diagnostic approach; Mortality rate.

Introduction

According to the World Health Organization (WHO), COVID-19 is responsible for more than 6 million deaths until April 16, 2020 [1]. The clinical picture varies from asymptomatic carriers to severe conditions leading to Systemic Inflammatory Response Syndrome (SIRS) and Multi-organ Dysfunction Syndrome (MODS) [2]. Therefore, detecting affected patients is not always feasible, especially in emergency conditions such as trauma [3].

Similar to COVID-19, trauma patients are at risk of developing various clinical conditions, including SIRS and MODS. These two clinical entities share several clinical and para-clinical similarities [4]. Therefore, trauma staff has faced several challenges in dealing with trauma patients during the COVID-19 pandemic. First, the clinical values are neither specific nor informative. We could not thoroughly attribute the general and respiratory symptoms such as fever, myalgia, cough, chest pain, and shortness of breath to the trauma, especially when there is a risk of concomitant COVID-19 infection [5]. Second, the para-clinical measures, such as quantitative reverse transcription-polymerase chain reaction (RT-PCR) and computed tomography (CT), lack sensitivity and specificity in the trauma setting. Moreover, our previous study has shown that chest CT images could not completely differentiate COVID-19 and trauma-related findings such as pulmonary contusions [6].

There is growing evidence of an increase report in mortality rate among COVID-19 patients compared with none COVID ones following surgeries. A multicenter retrospective study reported that the concomitant COVID-19 doubled the mortality risk in orthopedic and trauma patients [7]. Compared to the patients with negative RT-PCR tests, Thakrar *et al*., [8] showed a higher 30-day mortality rate in orthopedic patients with positive RT-PCR results. Other studies investigating orthopedic and trauma patients showed similar results [9, 10]. Therefore, the stakeholders suggest delaying elective or even semiurgent surgeries if the patients have a concomitant COVID-19 infection [10].

Trauma, however, is a non-deferrable condition that needs emergent, life-saving treatments. Concerning COVID-19, some issues should be addressed. First, trauma staff is at increased risk of unprotected close contact with the patients [3]. Second, they should assess the patients' conditions to dwindle possible patient-to-staff or patients-to-patients viral transmission. Moreover, patients with a decreased level of consciousness cannot provide informative COVID-19-related history [11].

Therefore, it is essential to know how COVID-19 affects the paraclinical and clinical course of trauma patients. To the best of our knowledge, not many studies have addressed this issue. Therefore, in this case-control study, we compared the clinical and paraclinical conditions between COVID+ve and-ve trauma patients. Our primary aim was to investigate any differences between these two groups. Finally, we sought to know how such possible differences affect patients' outcomes.

Materials and Methods

This case-control study was conducted according to the Strengthening the Report of Observational Studies in Epidemiology (STROBE) Statements [12]. All adult trauma patients admitted to Shahid Rajaee Trauma Hospital from February 20, 2020, to June 21, 2021, were recruited. A pilot study conducted in our center had shown that the mortality rates (proportion of subject: q_1 and q_0) in the PCR+ve and PCR-ve groups are 18% and 5%, respectively. Considering the type I error (α) 5%, power 80%, and based on the formula comparing two proportions, the sample size was calculated to be 95 patients in each group. We selected patients by census sampling as cases (N=100 patients). We selected control groups by systematic random sampling (N=100 patients). Base on sorted patient list selected one patient form 46 patient randomly by chart number. There is no difference in age and gender between case and control groups (Table 1).

The RT-PCR+ve group (case) had at least one positive PCR test during hospital admission or the last two weeks prior to the admission. If the first RT-PCR test was negative (control), the second test was conducted three days later from the lower respiratory tract. The indications for RT-PCR tests were detailed in our previous study [13]. All unstable, unconscious patients or those who required live-saving interventions are assessed with the RT-PCR tests (Stage1). Stage 2 focuses on the clinical and epidemiological risk factors, including the history of acute respiratory symptoms, positive epidemiological risk factors, temperature>38° c, Respiratory rate >20/min, or O_2 saturation<90%. Patients with at least two of these criteria were evaluated with RT-PCR and CT images. In the next stage (Stage 3), the presence of leukocytosis with lymphopenia and elevated ESR or CRP are the main indications for the RT-PCR test. In the last stage, if a patient does not meet any criteria mentioned above, they will be monitored considering the emerging COVID-19-related signs and symptoms [13]. The RT-PCR -ve group consisted of patients with negative PCR tests and negative COVID-19-related chest CT findings.

The inclusion criteria were (1) adult patients (age$\geq$18 years old), (2) admitted to our hospital from February 20, 2020, to June 21, 2021, and (3) assessed with COVID-19 RT-PCR tests and chest CT images. The exclusion criteria were (1) age less than 18 years of age, (2) patients without chest CT images, (3) having incomplete medical records, and (4) died/ discharged/ released from the hospital less than 24 hours after hospital presentation, because such patients have incomplete records.

The demographic features, laboratory and clinical data during the first 24 hours after hospital admission, mechanism of injury, and injury severity score (ISS) were collected. Any missing data were retrieved after reviewing patients' medical records. "Other" MOI was selected if the exact MOI could not be determined. A blind board-certified radiologist reviewed the chest CT images according to the RSNA criteria provided by the Radiological Society of North America [14].

The ICU-related variables were obtained from

Table 1. Demographic features of enrolled patients by COVID-19 status (n=200).

Demographic Characteristics	COVID-19 PCR[a] test		p value
	Negative (n=100)	Positive (n=100)	
Age, Mean (SD[b])	48.11 (21.11)	48.10 (22.69)	0.997
Male Gender, n (%)	75 (75)	76 (76)	0.869
ISS[c], Median (IQR)	14 (17)	14 (18)	0.507
ISS[c], n (%)			
1-8	23 (23)	25 (25)	0.897
9-15	29 (29)	26 (26)	
16-24	21 (21)	24 (24)	
25-49	27 (27)	24 (24)	
≥ 50	0	1 (1)	
APACHE[d], Median (IQR[e])	13 (7)	12 (10)	0.374
NEWS[f]2 score, Median (IQR[e])	5 (5)	5 (5)	0.656
Shock Index, Median (IQR[e])	0.68 (0.24)	0.69 (0.25)	0.732
Comorbidities*, n (%)			
Smoker	11 (11)	3 (3)	0.027
Opium	10 (10)	5 (5)	0.179
Liver Disease	1 (1)	1 (1)	>0.999
Diabetes	10 (10)	7 (7)	0.447
Ischemic Heart Disease	8 (8)	5 (5)	0.390
Hypertension	19 (19)	16 (16)	0.577
End-Stage Renal Disease	3 (3)	2 (2)	>0.999
Obstructive Lung Disease	6 (6)	3 (3)	0.498
Restrictive Lung Disease	0	2 (2)	0.497
Neurologic Disorders	3 (3)	3 (3)	>0.999
Cerebrovascular Accident	3 (3)	2 (2)	>0.999
Seizure	1 (1)	3 (3)	0.621
Rheumatoid Arthritis	3 (3)	1 (1)	0.621

[a]PCR: Polymerase chain Reaction; [b]SD: Standard Deviation; [c]ISS: Injury Severity Scale; [d]APACHE: Acute Physiology and Chronic Health Evaluation; [e]IQR: Interquartile range; [f]NEWS: National Early Warning Score; Several Comorbidities were asked and only positive ones were reported.

Iran Intensive Care Unit Registry (IICUR). IICUR was approved by the Ethics Committee of Shiraz University of Medical Sciences in 2018 (Ethic Number IR.SUMS.REC.1397.559) and recognized by the Iran Ministry of Health as the first and the only registry of adult ICU in Iran. Since then, it has been expanded to other ICUs all over the country. The primary purpose of IICUR is to provide a platform for researchers, clinicians, and administrators where they can collaborate to measure, report, benchmark, and improve ICU and hospital outcomes such as mortality and length of stay. IICUR includes patients admitted to the ICU (including readmissions) and those admitted/readmitted to other units under the umbrella care of the ICU. Patients admitted to ICU (or other units) for solitary procedures (e.g., central line insertion) and coronary care admissions to combined ICU/CCUs are excluded.

The primary outcome was the in-hospital mortality rate. The secondary outcome was hospital and ICU length of stay, ventilator days, and complications such as acute renal failure, acute hepatic failure, thrombosis, and secondary bacterial infection.

Data were analyzed using SPSS software version 27 (IBM Corp., Armonk, NY). The Kolmogorov-Smirnov test was used for each variable to assess normal distribution. Quantitative variables were described as mean (SD) or median with interquartile range (IQR) when appropriate, and the student sample t-test or Mann-Whitney tests were used to compare variables between the PCR+ve and -ve groups. Frequency (%) and Chi-square or Fisher exact tests were used to describe and analyze qualitative measures. Multivariable binary logistic regression analysis was done to investigate the variables predicting COVID-19 (primary analysis) and mortality rate (secondary analysis). In all comparative tests, statistical significance was set for a two-tailed *p*-value less than 0.05.

This study was conducted in line with the Declaration of Helsinki. The institutional review board and ethics committee of Shiraz University of Medical Sciences has approved this study with the ethics number of IR.SUMS.REC.1400.276. This study was deemed exempt from the need for consent.

Results

Four thousand six hundred eighty-three patients were tested for COVID-19. Of those, 635 tests (13.5%) were positive (PCR+ve group). The mean (SD) age of all included patients was 48.11 (21.81). About three-fourths of them were men. Table 1 shows that the PCR+ve and -ve groups are similar in terms of

ISS (p=0.897), shock index (p=0.732), APACHE II (p=0.374), and NEWS scores (p=0.656). The smoking frequency was significantly higher in the PCR -ve group (11% vs. 3%, p=0.027). Other comorbidities were reported almost uniformly.

Table 2 outlines the injury-related features and presenting vital signs. The mechanisms of injury distribution and the presenting vital signs differs between the two groups, although they were not statistically significant. The PCR -ve patients had a higher rate of chest wall trauma (47% vs. 30%, p=0.013).

According to the guidelines provided by RSNA criteria, the chest CT images were reviewed by a board-certified radiologist and intensivist and

summarized in Table 3. Normal (42.0%), atypical (27.0), and typical (21.0%) chest CTs were the three most frequent RSNA classifications in the PCR+ve group. Moreover, the overall incidence of rib fracture was significantly higher among PCR+ve group. We categorized the rib injuries according to the number of involved ribs. Other findings were not significant. Out of twenty-two PCR -ve patients with rib fractures, nineteen cases (86.4%) had three or more rib fractures. Other radiological findings were similar.

The COVID-19-related signs and symptoms are reported in Table 4. PCR+ve patients reported more headache (6% vs 0%, p=0.029) and myalgia (22% vs 4%, p<0.001). Other clinical findings were almost similar between the groups and were insignificant.

Table 2. Injury-related characteristics of enrolled patients by COVID-19 status (n=200).

Variables	COVID-19 PCR[a] test		p value
	Negative (n=100)	Positive (n=100)	
Mechanism of Trauma			
Falling	37 (37)	41 (41)	0.102
RTA[b]	60 (60)	48 (48)	
Penetrating	1 (1)	5 (52)	
Other Blunt Trauma	2 (2)	6 (6)	
Associated injuries			
Head and neck	38 (38)	50 (50)	0.087
Spine	22 (22)	12 (12)	0.060
Chest	47 (47)	30 (30)	0.013
Abdominopelvic	23 (23)	17 (17)	0.289
Extremities	37 (37)	33 (33)	0.553
Presenting Vital Signs			
GCS[c]≤8	22 (22)	14 (14)	0.141
SBP[d]≤90	10 (10)	5 (5)	0.179
PR[e], mean (SD[f])	88.67 (17.35)	91.63 (17.08)	0.226
SPO2[g]%	94 (4)	95 (4)	0.246
RR[h]	16 (4)	17 (2)	0.091
T[i]	37 (1.55)	37 (1.5)	0.176

[a]PCR: Polymerase Chain Reaction; [b]RTA: Road Traffic Accident; [c]GCS: Glasgow Coma Scale; [d]SBP: Systolic Blood Pressure in mmHg; [e]PR: Pulse Rate (beat/min); [f]SD: Standard Deviation; [g]SPO2: Oxygen Saturation; [h]RR: Respiratory Rate; [i]T: Temperature in degree of Celsius; *were reported as Median and interquartile range. Others were described as frequency and percentage

Table 3. Computed tomography findings of enrolled patients by COVID-19 status (n=200).

Chest CT[b] findings, n (%)	COVID-19 PCR[a] test		p value
	Negative	Positive	
RSNA[c]			
Typical	0	21 (21)	<0.001
Indeterminate	10 (10)	10 (10)	>0.999
Atypical	51 (51)	27 (27)	<0.001
Normal	39 (39)	42 (42)	0.666
Lung involvement*	18.03 (12.30)	21.47 (15.88)	0.189
Pneumothorax	13 (13)	6 (6)	0.091
Hydrothorax	18 (18)	18 (18)	>0.999
Rib Fracture	22 (22)	10 (10)	0.021
≥3	19 (86.4)	5 (50.0)	0.018
2	3 (13.6)	2 (20.0)	
1	0	3 (30.0)	
Diaphragmatic Rapture	1 (1)	3 (3)	0.621
Emphysema	11 (11)	5 (5)	0.118

[a]PCR: Polymerase Chain Reaction; [b]CT: Computed Tomography; [c]RSNA=Radiological Society of North America; *patients with normal chest CT were excluded.

Table 4. Clinical signs and symptoms of enrolled patients by COVID-19 status (n=200).

Presenting Signs and Symptoms, n (%)	COVID-19 PCRᵃ test		*p* value
	Negative	**Positive**	
Flu-like symptoms			
Fever	37 (37)	27 (27)	0.130
Cough	12 (12)	11 (11)	0.825
Myalgia	4 (4)	22 (22)	<0.001
Respiratory Distress	31 (31)	23 (23)	0.203
Chest Pain	1 (1)	3 (3)	0.621
Headache	0	6 (6)	0.029
Neurological Symptoms			
Anosmia	0	2 (2)	0.497
Ageusia	0	0	0
Decreased LOCᵇ	18 (18)	17 (17)	0.852
Dizziness	0	2 (2)	0.497
GI symptoms			
Abdominal Pain	1 (1)	0	>0.999
Nausea	0	1 (1)	>0.999
Vomiting	0	0	0
Diarrhea	0	0	0
Anorexia	5 (5)	0	0.059

ᵃPCR: Polymerase Chain Reaction; ᵇLOC: Level of Consciousness

Table 5. On-hospital Arrival Laboratory findings of enrolled patients by COVID-19 status (n=200).

Laboratory Data, Median (IQRᵇ)	COVID-19 PCRᵃ test		*p* value
	Negative	**Positive**	
White Blood Cells, $*10^6$/L	12.65 (7.17)	10.75 (7.27)	0.024
Lymphocytes count, $*10^6$/L	1.66 (1.61)	1.41 (1.45)	0.030
NLRᶜ	5.77 (6.26)	6.25 (6.7)	0.617
Hemoglobin, gr/dL	13.3 (3.05)	13.35 (3.73)	0.993
Platelet, $*106$/L	212.5 (74.25)	208.5 (95)	0.531
BUNᵈ, mg/dL	16 (6.75)	15 (9.82)	0.612
Creatinine, mg/dL	1.11 (0.33)	1.03 (0.44)	0.032
Sodium, mEq/L	137 (4)	138 (4)	0.499
Potassium mEq/L	4 (0.6)	4 (0.7)	0.354
Calcium, mg/dL	8.2 (0.90)	8 (0.80)	0.127
Magnesium, mg/dL	1.8 (0.3)	2 (0.45)	0.005
PTᵉ, sec.	12.9 (1.85)	12.7 (1.87)	0.732
PTTᶠ, sec	27 (4)	32 (9)	<0.001
INRᵍ	1.21 (0.27)	1.17 (0.26)	0.720
ASTʰ, U/L	49 (47)	34.5 (41)	0.027
ALTⁱ, U/L	32 (42)	35 (36)	0.892
ALK.Pʲ, U/L	147 (84.25)	150 (82.75)	0.835
Direct Bilirubin, mg/dL	0.31 (0.2)	0.32 (0.25)	0.360
Total Bilirubin, mg/dL	0.84 (0.55)	0.79 (0.47)	0.225
Albumin, g/Dl	3.3 (0.9)	3.3 (0.75)	0.817
Total Protein, g/dL	5.6 (1.3)	5.4 (1)	0.287
CPKᵏ, U/L	778 (1946.5)	411 (928.75)	0.006
LDHˡ, U/L	719.5 (649.75)	506 (425)	0.006
ESRᵐ, mm/h	21.5 (47.75)	23 (41.5)	0.558
CRPⁿ, mg/L	24 (50.75)	17 (42.5)	0.004
Ferritin, µg/L	287 (613)	301 (507)	0.597
D-Dimer, ng/mL	3254 (6163)	2542 (4911)	0.435
Fibrinogen, mg/dL	269 (85.5)	242 (75)	0.105
Troponin, pg/mL	11.5 (50.98)	3.9 (24.1)	0.019

ᵃPCR: Polymerase Chain Reaction; ᵇIQR: Interquartile range; ᶜNLR: Neutrophil to Lymphocyte Ratio; ᵈBUN: Blood Urea Nitrogen; ᵉPT: Prothrombin Time; ᶠPTT: Partial Thromboplastin Time; ᵍINR: International Normalized Ratio; ʰAST: Aspartate Aminotransferase; ⁱALT: Alkaline Aminotransferase; ʲALK.P: Alkaline Phosphatase; ᵏCPK: Creatinine Phosphokinase; ˡLDH: Lactate Dehydrogenase; ᵐESR: Erythrocyte Sedimentation Rate; ⁿCRP: C-reactive Peptide

We run a complete laboratory profile to find any significant differences guiding us to diagnose COVID-19 among trauma patients. The results of the univariate analysis are shown in Table 5. The PCR+ve group had a significantly lower median of white blood cells (10.75[7.27] vs. 12.65 [7.17], p =0.024), lymphocyte (1.41 [1.45] vs. 1.66 [1.61], p =0.030), creatinine (1.03 [0.44] vs. 1.11 [0.33], p=0.032). Interestingly, the serum level of creatinine phosphokinase, lactate dehydrogenase, and C-reactive peptides was lower in the PCR+ve group than in the negative group (Table 5). However, none of these findings were significant in the multivariate regression analysis.

Considering the outcomes, a significantly higher number of patients in the PCR+ve group were admitted to ICU wards than in the negative group (82.0% vs. 69.0%, p=0.030). Clinically, the PCR -ve group was intubated more frequently with more invasive ventilation supports. However, they were not statistically significant (p=0.495 and p=0.389, respectively). Finally, the in-hospital mortality rate (p=0.160) and complications, as well as the hospital and ICU length of stay (p=0.631 and 0.608, respectively), were comparable between the two groups (Table 6).

We recruited all p-values > 0.2 in the multivariate regression analysis to find a pattern detecting COVID-19 among trauma patients. None of these findings were significant (results were not shown). Moreover, we run a second analysis to determine how these findings affect the mortality rate (Table 7). The multivariable logistic regression analysis shows that comparing the PCR -ve patients, PCR+ve ones had increased odds of death (OR=2.88; 95% CI=1.22-7.41). With each day of ICU admission, the Odds of death increase by 13% (OR=1.13; 95% CI=1.07-1.20).

Discussion

Trauma and COVID-19 share similar clinical and paraclinical similarities. According to the current study, univariate analysis showed that PCR+ve trauma patients had a significantly lower chest wall trauma rate, lower incidence of rib fractures, and a higher rate of ICU admission. The incidence of headaches among trauma patients who tested positive for COVID-19 was higher than in the PCR-ve groups. More patients in the PCR+ve group received steroids, and the incidence of multiple rib fractures (≥3 ribs) was lower in the PCR+ve group. However, none of these para-clinical values showed statistical significance with regard to the multivariate analysis. Trauma could easily mimic or even mask the signs and symptoms of COVID-19 diseases. Both conditions could elevate body temperature, induce hypoxia and alter the respiratory rate, heart rate, and blood pressure. On the other hand, post-traumatic hypothermia could mask COVID-19-induced fever.

Trauma and COVID-19 disease are both polyphasic inflammatory conditions. Laboratory results vary widely regarding the severity and the phases

Table 6. Patients' outcomes by COVID-19 status (n=200).

Outcomes	COVID-19 PCR test		*p* value
	Negative	**Positive**	
Intubation	44 (44)	38 (38)	0.495
MV Days[a]	5 (7)	5 (6)	0.402
Ventilation			
O2 supply	56 (56)	62 (62)	0.389
Invasive MV	44 (44)	38 (38)	
FiO2 ≥40%	59 (59)	62 (62)	0.329
Complications			
Thrombosis	6 (6)	7 (7)	0.774
Bleeding	7 (7)	8 (8)	0.788
Sepsis	30 (30)	25 (25)	0.428
Acute Liver Injury	4 (4)	1 (1)	0.369
Acute Kidney Injury	5 (5)	10 (10)	0.179
ICU Admission Rate	69 (69)	82 (82)	0.030
In-hospital mortality	11 (11)	18 (18)	0.160
Survivors HLOS[a]	4 (4)	4 (4)	0.631
Survivors ICU-LOS[a]	4 (9)	4 (5)	0.608
Steroids	34 (34)	63 (63)	<0.001
Inotrope	11 (11)	9 (9)	0.637

[a] were reported as Median and interquartile range. Others were described as frequency and percentage

Table 7. Multivariate Analysis Predicting the Mortality Rate.

Significant Predictors	Mortality Odds Ratio (95% CI)	*p* value
Duration of ICU Admission	1.135 (1.073-1.200)	<0.001
Covid Positive	2.884 (1.122-7.414)	0.028

during which the patients present to the hospital. Inflammatory markers such as CRP, LDH, and CPK are routinely associated with more severe viral infections and worse outcomes among critically ill or septic patients [15-17]. These reports were inconsistent with our results. In our study, however, the patients were admitted to the hospital due to trauma (not COVID pneumonia). Moreover, we could not precisely track the time interval between the onset of COVID-19-related signs and symptoms and hospital admission. Therefore, these lab findings-taken on hospital arrival- are unreliable enough to help us predict patient outcomes.

Previous reports showed radiological similarities between COVID-19 and trauma patients sustaining chest wall trauma [6, 13, 18, 19]. These results are consistent with the previous study, which has shown that trauma patients with pulmonary contusions presented to a trauma center before the COVID-19 pandemic. They have shown that 80% of such patients had bilateral ground-glass opacity (GGO), which was a typical feature of COVID-19 (5). The CT images of 14 patients were reviewed by Akdogan *et al*., and 92.9 % and 85.7% had peripherally located GGO and subpleural lines, respectively [20]. Considering these similarities, CT images are not always a reliable differentiating tool. We suggest that the images should be reviewed with caution in the trauma setting when the risk of COVID-19 concurrent infection is high.

Considering the lower incidence of chest wall trauma, the overall rib fractures, and multiple (≥3) rib fractures, we primarily inferred that the volume of lung involvements should have been less in PCR+ve patients. However, the volume of lung involvement was higher in the PCR+ve group compared with that of the PCR -ve group, although it was not significant. Some researchers hypothesized that SARS-CoV-2 viruses increase lung parenchyma fragility resulting in a higher lung involvement with the same or even less severe trauma [13].

The secondary analysis showed that the PCR+ve trauma patients sustained more than 2.5-fold increased odds of death. Previously conducted studies support this finding [21-23]. An international multicenter study has shown that patients have a higher mortality rate and pulmonary complications following emergency general surgeries [24]. Several mechanisms are attributed to the increased mortality rate among trauma patients with positive PCR results in the literature. These were pulmonary and thrombotic complications [25, 26]. However, these complications were similar in our study. This discrepancy may be due to the fact that PCR-positive patients in the different studies did not have the same COVID-19 severity and disease activity [27]. During a propensity-matched study, Yeates *et al*., [27] failed to show any significant differences between the two trauma groups (PCR+ve and -ve groups), consistent with our results. Another contributing factor to the

increased mortality rate among our trauma patients with PCR+ve results may be the higher rate of steroids used in this group. Several studies reported that over-prescribing steroids were associated with increased mortality [28-31].

There were several limitations of this study. First, although we considered several strategies to address confounders, residual ones may skew our results. Second, considering the time interval, the chance of false-negative RT-PCR results could not be ignored entirely. Although the RT-PCR test is specific, several factors affect the sensitivity, such as operators' skills, the kits' sensitivity, and the time interval when the test was done. Therefore, the chance of including asymptomatic, PCR-ve patients could not be ruled out. Third, it was also unclear when the patients' symptoms started.

Last but not least, our study lacks the immunological assay investigating the serum level of inflammatory cytokines. Therefore, we do not know the exact differences in the immunological profiles between the two groups. We suggest a larger, multicentric prospective study be designed that carefully assesses the effect of different severities of COVID-19 patients on clinical and para-clinical characteristics of trauma patients. We have shown that comparing the clinical and paraclinical values is generally inconclusive. The multivariate regression analysis failed to mark any of these values guiding us to detect COVID-19 earlier in trauma patients. Moreover, trauma patients with positive PCR tests are at increased mortality risk. We suggest a larger, multicentric prospective study to be designed that carefully assesses the effect of different severities of COVID-19 patients on the clinical and paraclinical characteristics of trauma patients.

Declarations

read and approved the final manuscript.

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