Chest Computed Tomography for Screening Suspected Cases of SARS-CoV-2 Infection in Trauma Patients

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Abstract

Aim: To describe an institution’s experience with the implementation of a chest computed tomography (CT) protocol to screen suspected cases of COVID-19 among trauma patients.

Materials and methods: This is a longitudinal observational study, which was carried during 67 days of the COVID-19 pandemic. We included all adult trauma patients, who underwent chest CT at admission. According to the screening protocol, all patients with moderate/severe trauma requiring hospitalization and/or surgery underwent chest CT. Imaging suggestive of COVID-19 led to activation of infection control protocols in the operating room and during hospitalization. We performed univariate analysis to compare patients according to indication of chest CT (trauma mechanism or COVID-19 protocol).

Results: We included 352 patients. Mean age was 44.95 years, 74.64% were male. Most patients (72.16%) underwent chest CT due to mechanism of trauma. Nine (2.35%) patients had CT scans suggestive of COVID-19, seven of which were performed based on the screening protocol. Among these nine patients, three were symptomatic for COVID-19 and one had laboratory confirmation of SARS-CoV-2 infection. With respect to the patient subgroups according to CT scan indication, difference was observed regarding body injury location (p = 0.000), prevalence of COVID-19 symptoms (p = 0.014) and prevalence of altered imaging findings (p = 0.000).

Conclusion: Although further validation for this purpose is needed, chest CT has shown to be an important tool for screening suspected cases of COVID-19 in the context of trauma surgery.

Clinical significance: Improvement of COVID-19 screening in trauma settings can allow better allocation of resources and minimize viral transmission.

Keywords: Computed tomography, Coronavirus infections, COVID-19, Observational study, Protocols, Surgery, Trauma surgery care.

Introduction

On March 11, 2020, the World Health Organization (WHO) characterized COVID-19 as a pandemic. Most patients infected with SARS-CoV-2, the etiologic agent of COVID-19, may initially be oligosymptomatic, even those individuals presenting the pulmonary form of the disease. As a result, many trauma patients can arrive at the emergency department without signs or symptoms compatible with COVID-19 and, even so, be active agents for disease transmission.2,3

Pandemics generate socioeconomic crises and may overload the healthcare system, similarly to what might be seen in periods of war. This leads to the need in the adjustments for the previously established forms of care, aiming at the rational use of material, physical, and human resources so as to reserve them for a future

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of potential scarcity. Previously established guidelines, such as indication criteria for computed tomography (CT) scans in the trauma care setting, can be expanded aiming at diagnosis of SARS-CoV-2 infections. Early diagnosis of COVID-19 allows for adequate precaution measures to be taken to avoid transmission to other patients and healthcare professionals.²,⁴

Before COVID-19 was declared as a global pandemic, we were already living in the midst of another endemic, trauma. Approximately 6 million people, from different age and socioeconomic groups, die every year from unintentional injuries and violence around the world.⁵ External causes represent the main causes of death in the first four decades of life, being responsible for the loss of more years of productive life than heart disease and cancer.⁶ It is estimated that more than nine people die every minute from injuries to internal organs or violence, reaching a total of approximately 5 million deaths every year from these causes.⁵

The emergence of the pandemic prompted many countries to adopt public policies of social isolation in order to reduce viral transmission. This led to a decrease in mobility of individuals and a consequent reduction in the number of accidents involving transportation vehicles or work-related trauma. However, it has been observed that the number of trauma injuries inside homes and those caused by interpersonal violence have remained stable or even increased.⁷-⁹

Therefore, the combination of continuously high rates of trauma injury and a pandemic infection that is often asymptomatic results in an urgent need for changes in the way we care for trauma patients. These include early diagnosis of asymptomatic patients for COVID-19 and measures to reduce viral transmission to other patients and health professionals. Many emergency services are establishing measures such as expanding indication criteria for chest CT among trauma patients, based on protocols by countries that faced the pandemic earlier.²,⁴,¹⁰-¹² These measures require constant analysis for adjustments and improvements throughout the pandemic.

This study aimed to describe our experience with the implementation of chest CT as a protocol for screening suspected cases of SARS-CoV-2 infection in trauma patients during the COVID-19 pandemic.

MATERIALS AND METHODS

Study Design, Inclusion, and Exclusion Criteria

This is a longitudinal observational study, approved by the Human Research Ethics Committee CEPSH-SESA/HT (CAAE 306,37720.4.0000.0008).

Were included in the study all adult trauma patients (18 years old and over), who received trauma care at Hospital do Trabalhador in Curitiba, Brazil, between March 11, 2020 and May 21, 2020. All patients included in the study underwent chest CT at time of admission to the emergency department. The Hospital do Trabalhador is a state reference trauma center and is also currently one of the state reference centers for the care of patients with SARS-CoV-2 infection during the pandemic. The starting date for the study period was based on the date COVID-19 was first considered a pandemic by the WHO. Patients who were transferred to another hospital during hospitalization were excluded from the study.

Protocol with Chest Computed Tomography and RT-PCR Testing for SARS-CoV-2

The protocol was applied to those patients with moderate to severe trauma injuries and with need for hospitalization and/or surgery. All patients with these criteria underwent chest CT, regardless of the body part where impact or injury occurred. Imaging was performed on a Bright Speed GE® 16-channel equipment. In this study, patients were submitted to noncontrast CT. Scanning parameters included tube voltage of 120 kV, tube current 300 mA, and slice thickness of 1.25 mm. The tomography room at the institution where this study was conducted is connected to the initial trauma care room, with no need for patient transportation. Thus, there is no significant impact on the time to perform the exam as well as time to start treatment of critically ill patients. Previously to this protocol, we had already expanded the use of tomography at the institution, even for patients with penetrating trauma lesions, without impact on clinical and surgical outcomes of these patients.¹³

Patients with evidence of ground-glass pulmonary opacities and/or consolidations, with predominantly peripheral distribution,¹⁴ were considered suspected cases for COVID-19 and managed as infected, activating specific protocols in the operating room and for respiratory isolation. Examples of tomographic images obtained in this study are included for reference (Figs 1 and 2).

Data Collection

Data collection for this study was based on review of electronic medical records. Variables analyzed included patient demographic...
characteristics, mechanism of trauma, and body location of the impact or injury. Data on admission and hospital stay were also analyzed, including length of hospital stay and in-hospital mortality. We also analyzed the presence of symptoms suggestive of SARS-CoV-2 infection at admission, the reason for performing chest CT, findings observed on imaging, and the result of RT-PCR tests for SARS-CoV-2 when performed.

Statistical Analysis
Measures of central tendency and dispersion were expressed as means and standard deviation for continuous variables, and in absolute and relative frequencies for categorical and ordinal variables. We performed Shapiro-Wilk tests and generation of histograms to analyze the data distribution.

Univariate analysis was performed comparing two subgroups of patients by indication for chest CT (trauma mechanism vs COVID-19 screening protocol). Analysis was conducted using T test for normal continuous dependent variables, Mann-Whitney test for non-normal continuous dependent variables, and Chi-Square for categorical dependent variables. The level of significance was established at 5% for this study. Statistical analysis was performed using the statistical software Stata version 14.2.

RESULTS
Data were collected from a 67-day period. During this time, a total of 5,017 patients were admitted to the institution's emergency department, 2,380 of whom arrived by ambulance transportation. Among these, 352 patients were included in the study, according to the inclusion criteria previously discussed (Table 1). Patient mean age was 44.95 ± 18.31 years old, and 262 (74.64%) were male. Most patients (79.2%) did not have previous comorbidities.

In the sample analyzed, 301 (86%) patients suffered blunt trauma, and 193 (59.38%) patients had trauma involving the thoracic region (isolated or combined with trauma located in other body regions).

Thirty-eight (10.8%) patients had symptoms suggestive of COVID-19, including runny nose, cough, dyspnea, and fever. All patients included in this study underwent chest CT, with 72.16% having done the exam due to the trauma mechanism and possible associated injuries, while the other 27.84% were performed due to the ongoing screening protocol for SARS-CoV-2 infections at the institution (Table 2).

Imaging suggestive of SARS-CoV-2 infections on chest CT was observed in nine (2.56%) patients, seven of which were performed due to the COVID-19 screening protocol (Table 3). Of these nine exams suggestive of COVID-19, three patients had symptoms compatible with SARS-CoV-2 infection, while the others were asymptomatic. The average peripheral oxygen saturation in this group of patients was 94.75 ± 5.01%. Of the nine patients in question, only one tested positive for RT-PCR for SARS-CoV-2, and this patient was asymptomatic.

Regarding morbidity and mortality outcomes (Table 4), 47.16% of the patients in the sample did not require hospitalization, receiving hospital discharge after medication, exams, and observation. Surgical procedures during hospital stay were performed in 121 (34.38%) patients, four of which presented tomographic changes suggestive of SARS-CoV-2 infection. The overall length of hospital stay was 5.19 ± 10.99 days.

The great majority of patients (90.34%) did not present complications during hospitalization. Among the 34 patients that had complications, a total of 11 (3.12% of the total sample) progressed to in-hospital death.

Finally, when analyzing indication of chest CT (trauma mechanism versus COVID-19 screening protocol), the groups were not different in relation to sex, age, comorbidities, mechanism of trauma, or vital signs at admission (Table 5). However, a difference was observed between groups regarding the body region where trauma occurred (p = 0.000) and the presence of symptoms suggestive of COVID-19 (p = 0.014). Patients with thoracic trauma were in almost all cases (98.45%) submitted to chest CT due to the mechanism of trauma, while those with lesions in other body regions most often underwent chest CT for COVID-19 screening (65.15%). Regarding the presence of symptoms suggestive of COVID-19, asymptomatic patients underwent tomography due to trauma mechanism in 74.20% of the cases. Among symptomatic patients, the trauma mechanism still remained as the main indication for chest tomography, however in only 55.26% of the cases.

In addition, a difference was seen between the two different CT indication groups in relation to the imaging findings (p = 0.000). Most patients with tomographic changes compatible

### Table 1: Patient demographic information

| Total (n = 352) |
|----------------|
| Male gender [n (%)] | 262 (74.64) |
| Age (mean, SD) | 44.95 (18.31) |
| Comorbidities [n (%)] |
| None | 278 (79.2) |
| One | 43 (12.25) |
| Two or more | 30 (8.55) |
| Mechanism of trauma [n (%)] |
| Penetrating | 49 (14) |
| Blunt | 301 (86) |
| Body region where trauma occurred [n (%)] |
| Thoracic trauma present | 193 (59.38) |
| Without thoracic trauma | 132 (40.62) |
| Vitals signs at time of admission (mean, SD) |
| Heart rate (bpm) | 87.42 (17.77) |
| Mean arterial pressure (mm Hg) | 95.46 (17.97) |
| Peripheral oxygen saturation (%) | 96.79 (2.79) |

### Table 2: Symptoms and laboratory exams for SARS-CoV-2

| Total (n = 352) |
|----------------|
| Symptoms suggestive of COVID-19 [n (%)] | 38 (10.8) |
| Reason for chest CT [n (%)] |
| Mechanism of trauma | 245 (72.16) |
| COVID-19 screening protocol | 98 (27.84) |
| Findings in chest CT [n (%)] |
| Findings related to mechanism of trauma | 104 (29.55) |
| Findings suggestive of COVID-19 infection | 9 (2.56) |
| No findings related to mechanism of trauma or COVID-19 infection | 239 (67.9) |
| Results of RT-PCR for SARS-CoV-2 [n (%)] |
| Negative | 7 (87.5) |
| Positive | 1 (12.5) |
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with the mechanism of trauma (95.19%) underwent imaging due to the trauma itself. Patients with findings suggestive of COVID-19 on chest CT, in turn, underwent imaging due to the COVID-19 screening protocol in 77.78% of cases.

**DISCUSSION**

After the WHO declared the COVID-19 pandemic on March 11, 2020,1 our institution made adjustments to protocols for the care of trauma patients. In addition, the institution has become a reference center for the care of patients with suspected or confirmed severe acute respiratory syndrome related to COVID-19.

Among these protocols, we adopted the use of chest CT for every trauma patient with the possibility of hospitalization and/or surgery. This protocol aimed to increase early diagnosis of asymptomatic COVID-19 cases, leading to targeted and efficient measures to minimize transmission to healthcare professionals and other patients.

**Table 3:** Patients with findings on chest CT suggestive of COVID-19 infection

| Patient | Gender | Age | Mechanism of trauma | Previous comorbidities | Symptoms suspected for COVID-19 | Reason for chest CT | Findings in chest CT | Outcome | Hospital length of stay (days) | RT-PCR for SARS-CoV-2 |
|---------|--------|-----|---------------------|------------------------|--------------------------------|------------------|---------------------|---------|-------------------------------|---------------------|
| 1       | M      | 24  | Blunt on lower extremities | –                      | –                              | COVID-19 protocol | Ground-glass opacities | Hospital stay with surgical procedure and complications; hospital discharge | 8                   |
| 2       | M      | 24  | Blunt on head, abdomen, upper, and lower extremities | –                      | –                              | COVID-19 protocol | Ground-glass opacities | Hospital discharge | 0                  |
| 3       | M      | 56  | Blunt on thorax | –                      | –                              | Mechanism of trauma | Ground-glass opacities, rib fracture, pneumothorax | Hospital stay with surgical procedure; no complications; hospital discharge | 5 Positive |
| 4       | M      | 74  | Blunt on head | Hypertension, diabetes, Alzheimer’s Disease | Cough and fever | COVID-19 protocol | Ground-glass opacities | Hospital stay with surgical procedure and complications; hospital discharge | 23 Negative |
| 5       | M      | 44  | Blunt on thorax and abdomen | –                      | –                              | Mechanism of trauma | Ground-glass opacities | Hospital discharge | 0 Negative |
| 6       | M      | 61  | Blunt on head | Hypertension | Cough | COVID-19 protocol | Ground-glass opacities | Hospital discharge | 0 Negative |
| 7       | M      | 34  | Penetrating on head | –                      | Cough | COVID-19 protocol | Ground-glass opacities | Hospital stay without surgical procedure or complications; hospital discharge | 4                   |
| 8       | M      | 38  | Blunt on head | Schizophrenia | –                             | COVID-19 protocol | Ground-glass opacities | Hospital stay with surgical procedure; no complications; hospital discharge | 14 Negative |
| 9       | M      | 53  | Blunt on head and upper extremities | Alcohol abuse disorder | –                             | COVID-19 protocol | Ground-glass opacities | Hospital stay with surgical procedure; no complications; hospital discharge | 8 Negative |

M, Male

M, Male

**Table 4:** Patient outcomes

| Medical procedures n(%) | Total (n = 352) |
|-------------------------|-----------------|
| Medication and short-term observation only | 166 (47.16) |
| Hospital admission with surgical procedure | 121 (34.38) |
| Hospital admission without surgical procedure | 65 (18.47) |
| Length of hospital stay in days (mean, SD) | 5.19 (10.99) |
| Clinical outcome n(%) | No in-hospital complications; hospital discharge | 318 (90.34) |
| In-hospital complications; hospital discharge | 17 (4.83) |
| Death | 11 (3.12) |
| In-hospital complications; still an in-patient to this date | 6 (1.7) |
The clinical spectrum of SARS-CoV-2 infections ranges from asymptomatic to severe symptoms of respiratory failure. In addition, patients admitted to trauma emergency departments may be asymptomatic or unable to report symptoms due to the severity of trauma. If infected patients were taken for a surgical procedure without adequate precautions for respiratory transmission, the probability of contamination of healthcare professionals and even other patients in the anesthetic recovery room would be very high. Ideally, the use of personal protective equipment and other precautions for SARS-CoV-2 are recommended in all cases of patients undergoing surgical procedures during the COVID-19 pandemic, in order to minimize any chance of transmission. However, resource limitations are an issue to consider in the context of developing countries such as Brazil. Therefore, methods to diagnose suspected cases are essential for the appropriate allocation of equipment, materials, and human resources.

The use of chest CT as a method for diagnosing SARS-CoV-2 infection is based on protocols published at institutions
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The indication for tomography was mostly due to the trauma mechanism itself, with only 27.84% of the exams indicated as part of the COVID-19 screening protocol. Among all chest CT scans performed, nine (2.56%) presented findings compatible with COVID-19 infection, and one patient (asymptomatic) confirmed infection with RT-PCR testing.

In our study, among the 5,017 trauma patients seen in the emergency department, 352 (7.02%) underwent chest CT. The use of chest CT to screen suspected cases of COVID-19 in the emergency department, 352 (7.02%) underwent chest CT. The indication for tomography was mostly due to the trauma mechanism itself, with only 27.84% of the exams indicated as part of the COVID-19 screening protocol. Among all chest CT scans performed, nine (2.56%) presented findings compatible with COVID-19 infection, and one patient (asymptomatic) confirmed infection with RT-PCR testing.

Our institution’s experience evidenced an important number of trauma cases in a scenario of a disease pandemic (1) without defined treatment to the present date, (2) which can be asymptomatic, (3) with high transmissibility rates, and (4) with diagnosing exams that show a significant number of false negatives and require a relatively long time for analysis. In our sample, the detection of nine suspected cases for COVID-19 through the use of chest tomography allowed the adoption of measures to minimize the viral transmission to the team and other patients. Although confirmation with RT-PCR occurred in only one case in our sample, the possibility of identifying suspected cases prior to surgical procedures could justify the tomography protocol, as it allows for adequate allocation of resources and minimization of viral transmission.

CONCLUSION

The use of chest CT to screen suspected cases of COVID-19 in the context of trauma surgery, although still requiring further validation, remains an important tool for this purpose.

CLINICAL SIGNIFICANCE

Developing countries often face low availability of funding in healthcare, especially during times of socioeconomic and political crisis. The COVID-19 pandemic has led to the need to improve allocation of resources in healthcare and screening of COVID-19 suspected patients, with the goal of minimizing viral transmission and the inevitable impact of the pandemic on the quality of patient care delivered.

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