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 ($p = 0.000$), presence 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.

Resumo

Objetivo: Descrever a experiência de uma instituição na implementação de protocolo de rastreio de COVID-19 com tomografia computadorizada (TC) de tórax para pacientes vítimas de trauma.

Materiais e métodos: Estudo observacional longitudinal. Foram incluídos todos os pacientes adultos, vítimas de trauma, atendidos durante 67 dias na pandemia de COVID-19, e que realizaram TC de tórax na admissão. Pelo protocolo, pacientes com trauma moderado/grave com necessidade de internamento/cirurgia realizaram TC de tórax. Casos com TC sugestiva de COVID-19 foram manejados como infectados, ativando protocolos de controle de infecção no centro cirúrgico e no internamento. Análise univariada foi realizada para comparar subgrupos de pacientes conforme indicação da TC de tórax (mecanismo de trauma ou protocolo COVID-19).

Resultados: Foram incluídos 352 pacientes. A média etária foi 44,95 anos e 74,64% eram masculinos. A maioria dos pacientes (72,16%) realizou TC de tórax devido ao mecanismo de trauma. Nove pacientes (2,35%) apresentaram tomografias sugestivas de COVID-19, sendo sete destas realizadas pelo protocolo de rastreio. Desses nove pacientes, três eram sintomáticos e apenas um apresentou confirmação laboratorial de SARS-CoV-2. Em relação aos subgrupos de indicação da TC, houve diferença em relação à região corporal do trauma ($p = 0,000$), presença de sintomas ($p = 0,014$) e presença de alterações de imagem ($p = 0,000$).

Conclusão: A TC de tórax, apesar de ainda beneficiar de mais validação, mostra ser uma ferramenta importante para triagem de COVID-19 no trauma.

Significado clínico: Melhoras no rastreio de casos suspeitos de COVID-19 pode permitir melhor alocação de recursos e minimização de transmissão viral no contexto do trauma.

Palavras-chave: Cirurgia, COVID-19, Estudo observacional, Infecções por coronavirus, Protocolos, Tomografia, Traumatologia.

Introduction

On March 11, 2020, the World Health Organization (WHO) characterized COVID-19 as a pandemic.[1] 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 for adjustments in 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[R] 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
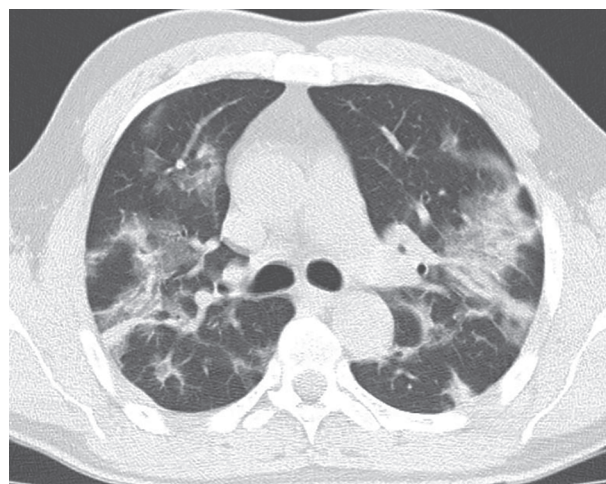

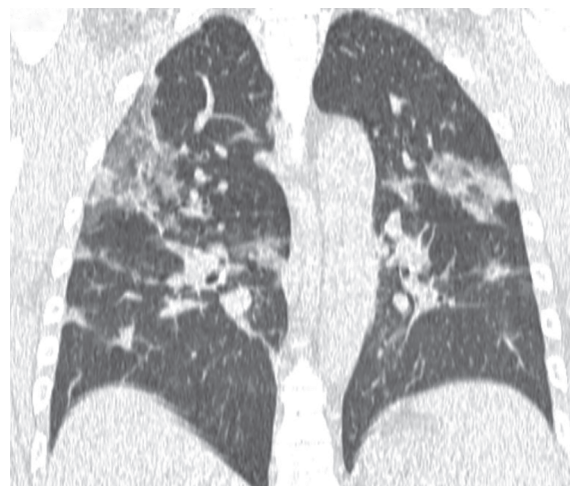**Fig. 1:** Representative chest computed tomography image, axial view

Fig. 2: Representative chest computed tomography image, coronal view

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-dayperiod. During this time, a total of 5,017 patients were admitted to the institution's emergency department, 2,380 of who 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

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)

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 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

Table 4: Patient outcomes

	Total (n = 352)
Medical procedures n(%)	
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)

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 imagining 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 5: Univariate analysis on subgroups according to reason for chest CT

	Chest CT due to mechanism of trauma (n = 254)	Chest CT due to COVID-19 screening protocol (n = 98)	p
Male gender [n (%)]	194 (74.05)	68 (25.95)	0.159
Age (mean, SD)	44.30 (1.13)	46.59 (1.96)	0.4102
Comorbidities [n (%)]			0.396
None	205 (73.74)	73 (26.26)	
One	28 (65.12)	15 (34.88)	
Two or more	20 (66.67)	10 (33.33)	
Mechanism of trauma [n (%)]			0.847
Penetrating	35 (71.43)	14 (28.57)	
Blunt	219 (72.76)	82 (27.24)	
Body region where trauma occurred [n (%)]			0.000 [a]
Thoracic trauma present	190 (98.45)	3 (1.55)	
Without thoracic trauma	46 (34.85)	86 (65.15)	
Vitals signs at time of admission (mean, SD)			
Heart rate (bpm)	87.70 (1.15)	86.7 (2.02)	0.4515
Mean arterial pressure (mmHg)	94.69 (1.18)	97.36 (1.99)	0.3193
Peripheral oxygen saturation (%)	96.77 (0.18)	96.84 (0.30)	0.8296
Symptoms suggestive of COVID-19 [n (%)]	21 (55.26)	17 (44.74)	0.014 [a]
Findings in chest CT [n (%)]			0.000 [a]
Findings related to mechanism of trauma	99 (95.19)	5 (4.81)	
Findings suggestive of COVID-19 infection	2 (22.22)	7 (77.78)	
No findings related to mechanism of trauma or COVID-19 infection	153 (64.02)	86 (35.98)	
Results of RT-PCR for SARS-CoV-2 [n (%)]			0.064
Negative	1 (14.29)	6 (85.71)	
Positive	1 (100)	0 (0)	
Medical procedures [n (%)]			0.247
Medication and short-term observation only	126 (75.90)	40 (24.10)	
Hospital admission with surgical procedure	81 (66.94)	40 (33.06)	
Hospital admission without surgical procedure	47 (72.31)	18 (27.69)	
Length of hospital stay in days (mean, SD)	5.62 (0.75)	4.09 (0.77)	0.243
Clinical outcome [n (%)]			0.221
No in-hospital complications; hospital discharge	232 (72.96)	86 (27.04)	
In-hospital complications; hospital discharge	12 (70.59)	5 (29.41)	
Death	5 (45.45)	6 (54.55)	
In-hospital complications; still an in-patient to this date	5 (83.33)	1 (16.67)	

[a] $p < 0.005$

The clinical spectrum of SARS-CoV-2 infections ranges from asymptomatic to severe symptoms of respiratory failure.[3] 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

across the world [2,4,10-12] and on recommendations from the American College of Surgeons.[15] Ai et al.[2] reported a series of 1,014 patients who underwent chest CT and RT-PCR as the gold standard for detecting SARS-CoV-2 infection. A total of 97% of patients with positive RT-PCR also had tomographic findings compatible with COVID-19, primarily showing ground-glass opacities. Tomography is a method available in trauma centers and could allow immediate diagnosis of trauma patients with need of surgical intervention. Specific tests for the detection of SARS-CoV-2, when available, require an analysis period longer than a scan. This period of analysis is also dependent on the number of tests awaiting analysis, which indicates that during the peak of the pandemic, the delay in result could be even greater. In the scenario of emergency surgeries, such as those for trauma that require prompt intervention, the assessment of risk of concurrent infection by SARS-CoV-2 also needs to be immediate. This allows efficient allocation of human and material resources, as well as preparation of the healthcare team, including use of adequate personal protective equipment, such as for orotracheal intubation.

In our study, among the 5,017 trauma patients seen 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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