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## Radiological analysis of acute pulmonary thromboembolism as a consequence of COVID-19: A case report

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### Abstract

SARS-CoV-2 is a virus of the coronaviridae family that causes COVID-19, a disease that emerged in 2019 and has already gone around the world, causing the World Health Organization to decree a pandemic state in 2020. One of the consequences of COVID-19 is the development of Pulmonary Thromboembolism (PE), a disease in which one or more pulmonary arteries are blocked by a blood clot. In this association with COVID-19, PE is caused by the pro-inflammatory and hypercoagulant state developed by the SARS-CoV-2 infection. To analyze aspects of both diseases, imaging tests such as computed tomography (CT) and chest radiography (X-ray) are commonly used. CT and X-ray are considered first-line imaging tools to assess the decline in cases of COVID-19, and besides that, multidetector CT pulmonary angiography (CTPA) can assist in the confirmation or exclusion of PE. Therefore, this case report is about imaging findings that correlate COVID-19 and PE.

**Keywords:** COVID-19, pulmonary embolism, cases report

### 1. Introduction

SARS-CoV-2, the causative agent of COVID-19, is a virus member of the coronaviridae family, composed of a single strand of RNA [1]. His emergence in Wuhan in 2019, which subsequently resulted in a worldwide pandemic declared by the World Health Organization in March 2020, placed him at the center of studies on his symptoms and transmissibility. The clinical picture of those infected is diverse. A cohort study conducted with data from 25 Brazilian hospitals attributes dyspnoea, cough and fever as the main causes of hospital admission [2]. Other common symptoms of respiratory infections may be present and cause confusion in the diagnosis, however, COVID-19 is differentiated by the greater propensity for a worse prognosis with the need for respiratory support and support from Intensive Care Units [3].

In more severe cases, it stands out the patient's tendency to evolve to a hyperinflammatory and hypercoagulant state that may culminate in the formation of venous and arterial thrombi, with emphasis on Pulmonary Embolism (PE). This can have a varied presentation, from asymptomatic to chest pain, dyspnea, hemoptysis and syncope [4]. The hypercoagulation present in patients with COVID-19 can be influenced by several mechanisms such as severe hypoxia, pre-existing comorbidities, and dysfunctions associated with systemic functioning that compromise hemostatic homeostasis [5]. Studies indicate that infection alone, without the presence of associated risk factors, considerably increases the risk of PE, since patients infected with SARS-CoV-2 in severe stages have the three factors attributed to thrombosis, known as Virchow's triad (endothelial injury, reduced flow, hypercoagulation state) [4,6].

In laboratory tests, the propensity to clots is perceived by the increase in the levels of D-dimer, fibrinogen and other products of fibrin degradation - the first being an important marker not only for screening the diagnosis, but also for the patient's prognosis [6,7].

The present report aims to present a case of acute PE due to SARS-CoV-2 infection and to contribute with scientific knowledge since there are still many gaps to be understood about the manifestations of the disease and its evolution.

## 2. Methods

Case report based on radiographic and sectional analysis and image findings of a case of Acute Pulmonary Thromboembolism resulting from COVID-19. The study had an Informed Consent Form prepared by the Ethics and Research Committee (CEP) of the University of the State of Mato Grosso (UNEMAT), which was signed by a family member, authorizing the use of the images and the case report in question.

## 3. Case report

After presenting symptoms suggestive of COVID-19, the patient M. de F. N., female, 59 years old, hypertensive, diabetic and obese, was admitted to the COVID-19 and Symptomatic Flu Center of Araputanga. Patient reported cough, fever and dyspnea on minimal effort. The spouse, although asymptomatic, presented a positive RT-PCR for COVID-19. At the serological test, the patient manifested positive IgM.

The physical examination revealed elevated systolic and diastolic blood pressure (BP 180x140 mmHg), feverish state (T<sub>0</sub> 40.0°C), hypoxemia (SpO<sub>2</sub> 87%) and pulmonary rales bilaterally, and oxygen therapy was the approach adopted along with the use of saline 250 mL (1 amp. Ceftriaxone + Dipyron).

The chest X-rays findings, taken one day after admission, revealed sparse bilateral and peripheral consolidations of mixed pattern with predominance of the lower and posterior lobes.

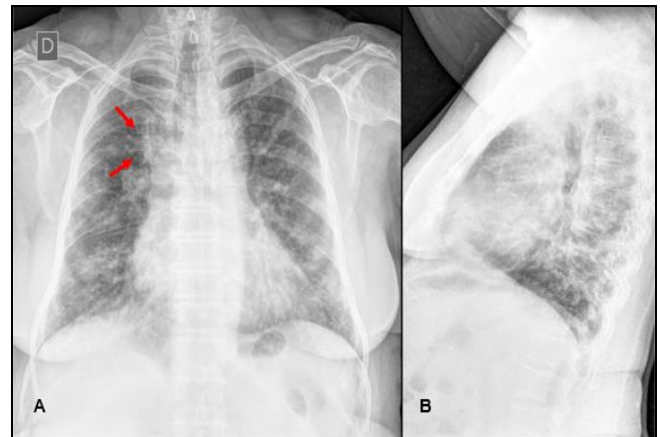
After the worsening of the situation, it was requested, through the National Regulation System (SISREG), a place in the Center for Intensive Care (CTI) of COVID-19. The patient was referred to the Intensive Care Unit (ICU) of the Cáceres Regional Hospital, using a high-flow nasal catheter. On the new admission, the rapid serological test was redone, making positive for COVID-19 and in the physical examination the patient was feverish (T° 38.8°C) and in a state of hypoxemia (SpO<sub>2</sub> 87%), and the condition was aggravated, suggesting Syndrome Severe Acute Respiratory System (SARS). The medication adopted in the new procedure was Amikacin, Polymyxin B, Meropenem and Clexane.

With the worsening of oxygen saturation (SpO<sub>2</sub> 85%), the patient was submitted to invasive mechanical ventilation (IMV) through orotracheal intubation (IOT). Chest High-resolution computed tomography (HRCT) was requested, showing the presence of ground-glass opacities, as well as sparse consolidation foci, with multifocal and bilateral distribution, with peripheral and posterior predominance, and greater extension in the lower lobes. The estimated extent of lung involvement on tomography is about 40-50% (visual and quantitative analysis). With no improvement in the condition, laboratory tests and CTPA were requested, confirming failure of pulmonary filling in the subsegmental branches of the pulmonary artery, compatible with acute PE. Six days after admission to the ICU of the Cáceres Regional Hospital, the patient died.

## 4. Results

The PA view of the chest x-ray showed multiple, bilateral and peripheral opacities throughout the pulmonary region, but predominantly in the lower and posterior lobes. The opacities were manifested in an irregular, diffuse form, with a mixed aspect evident in the middle and lower thirds due to

the presence of both alveolar opacities - ground glass - and interstitial infiltrates. Other punctuated findings were an increase in the reticulation of the pulmonary fields, an increase in the pulmonary hilum, dilation of the main pulmonary arteries bilaterally, an increase in density in the peribronchial regions, a poorly positioned trachea with a normal caliber and cardiomegaly. In the analysis of the images of the case, the Westermark sign was observed in PA and the loss of the more black sign on lateral X-rays.

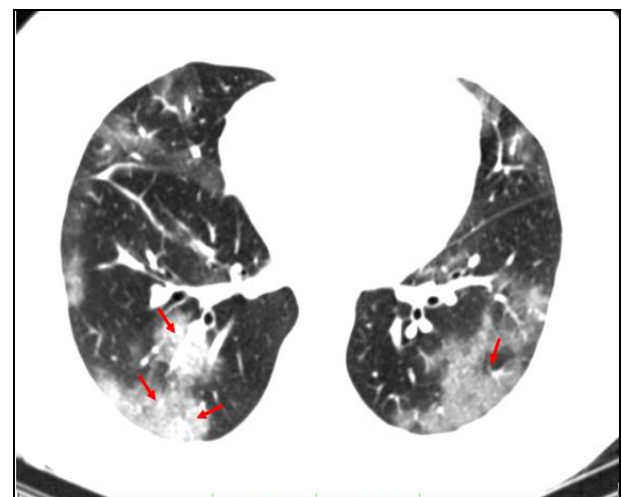


Source: from the author.

**Fig 1:** A) Simple chest X-ray in PA showing multiple, bilateral and peripheral opacities throughout the lung region - predominantly in the lower and posterior lobes. In addition, in the right lung, obstruction of some segmental branches reveals the Westermark sign (red arrow). B) Lateral X-rays showing the loss of the more black sign.

Laboratory tests showed multiple organ dysfunction, revealing in their results high creatinine (4.1 mg / dL), high urea (193 mg / dL), high TGP (1331 U / L), high lactate (4.9 mmol / L), high blood glucose (660 mg / dL) and high D-dimer (6600 ug / mL).

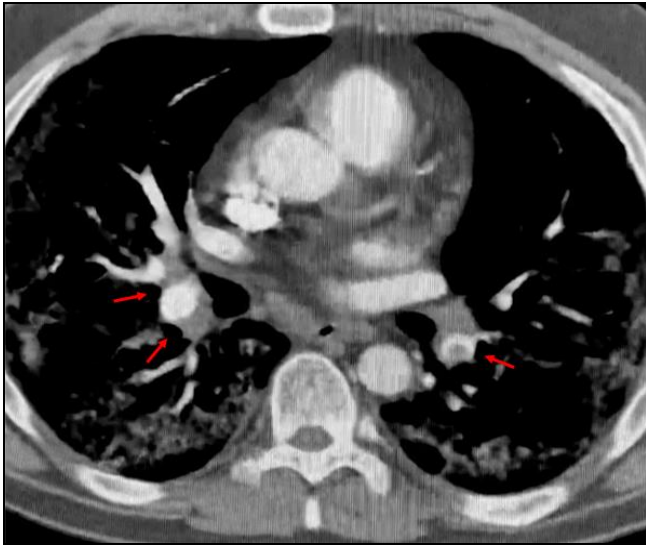
The first chest HRCT performed recorded multiple opacities of consolidative appearance bilaterally, with subpleural predominance and multilobar involvement, showing areas of ground-glass attenuation in the parenchyma. The ground-glass opacities and multifocal consolidative opacities showed the Halo sign.



Source: from the author.

**Fig 2:** Computed tomography of the chest in the axial plane, pulmonary window, showing ground-glass opacities and multifocal consolidative opacities, characterizing the halo sign (red arrow).

The images resulting from the chest CTPA, revealed extensive lung involvement, with diffuse alveolar opacities and areas of ground glass associated with thickening of the inter and intralobular septa, featuring a crazy-paving pattern. Besides, partial filling failures were noted in segmental arteries of the right middle lobe and left lower lobe, showing increased caliber.



Source: from the author.

**Fig 3:** CTPA axial plane, showing partial filling failures in arteries (red arrow), indicating PE.

## 5. Discussion

The case report deals with a patient infected with SARS-CoV-2 who developed acute PE and died eight days after seeking medical care due to symptoms related to COVID-19. Due to the underlying thrombotic - pro-inflammatory and hypercoagulable - environment characteristic of this viral infection, patients with COVID-19 are highly predisposed to pulmonary embolism<sup>[4]</sup>.

The patient had some comorbidities that are related to obesity in the SARS-CoV-2 infection. Individuals with diabetes mellitus, hypertension and severe obesity are more likely to be infected, have complications and progress to death<sup>[8]</sup>. In the report, the patient had both diabetes mellitus and systemic arterial hypertension (SAH), and his BMI was calculated at 36.62, placing him in the category Obesity II (severe). The prognosis, as presented, being common among these risk factors, culminated in death.

Among the aforementioned risk factors, obesity stands out because it can aggravate the condition by itself, without the need for accompanied comorbidities. The fact is explained by the chronic inflammatory state sustained by the excess of adipocytes in the obese patient. In turn, COVID-19 also induces an inflammatory factor in the systems by increasing cytokines (especially interleukin-6 (IL-6), which, in patients affected by the pathology, can be found in up to three times higher than normal). The sum of these factors leads to an increase in procoagulant factors and the consequent formation of thrombi<sup>[6]</sup>.

Knowing the risk factors, both for COVID-19 and for PE, the next step is to understand the conduct for diagnostic investigation. HRCT is considered the first-line imaging tool for assessing lung involvement by COVID-19<sup>[9]</sup>. However, not all health centers have this tool, thus using X-ray as a diagnostic option and, based on the picture pointed

out in the radiography result, they choose or not a new diagnostic approach, which may culminate in the transfer to a specialized pathology treatment network - as was the case of the patient in the present study.

The common findings of COVID-19 pneumonia are ground-glass opacities, reverse halo sign, pulmonary trunk dilation and increased cardiac volume (particularly, enlargement of the right cardiac chamber), these should indicate a risk of pulmonary embolism, as was also seen in two CT scans reported in the case presented. Aspects such as these can help the responsible medical professional to request a CTPA to confirm or exclude PE<sup>[9]</sup>, as occurred in the case of the report.

In addition to the evaluation by imaging exams, laboratorially it is possible to evaluate the evolution of COVID-19 and its consequences in different organs through the examination of urea, creatinine, TGP, lactate, glycemia and D-dimer. The latter is important for the initial suspicion of PTE or DVT (Deep Venous Thrombosis)<sup>[4]</sup>. Studies show that abnormal coagulation parameters (high levels of D-Dimer and fibrin degradation products) correlate significantly with mortality in patients with COVID-19. [9]. A French cohort study, however, explains that high levels of D-Dimer may or may not be linked to PE, so the mortality rate seen in patients with high rates of this substance is not necessarily correlated with the incidence of PE, which is reflected in the guidance of the International Society for Thrombosis and Hemostasis not to perform routine screening for PE in patients with high levels of D-Dimer infected by SARS-Cov-2<sup>[10]</sup>.

## 6. Conclusion

The association between COVID-19 and Acute Pulmonary Embolism is serious. The presence of previous risk factors such as SAH, diabetes mellitus and obesity are estimated to be relevant to the prognosis of the disease. The standard diagnosis is made through computed tomography of the chest without enhancement - health services that do not have CT, adopt the x-ray as the first line and then reflect on the conduct to be followed according to the data found. The analysis of laboratory data is important for monitoring the evolution of the infection and its repercussions - especially D-Dimer -, but studies indicate that it should not be used as a determinant for the screening of PE. The findings found in the imaging exams were characteristic of thrombotic events and the performance of angiotomography with a protocol for PE (CTPA) was essential to confirm the diagnosis.

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