

COVID-19 as a confounding factor in a child submitted to staged surgical palliation of hypoplastic left heart syndrome: One of the first reports of SARS-CoV-2 infection in patients with congenital heart disease



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In December 2019, in the province of Wuhan, China, authorities identified an outbreak of pneumonia caused by a novel coronavirus, colloquially referred to as COVID-19. The virus has now spread worldwide, reaching pandemic proportions.¹ Although adult patients with cardiovascular comorbidities are at increased risk of progressing with the severe form of the disease,² it is not known whether the same holds true for children with congenital heart disease (CHD). Furthermore, both the incidence of infection and severity of disease seem to be much lower in children than in adults.³

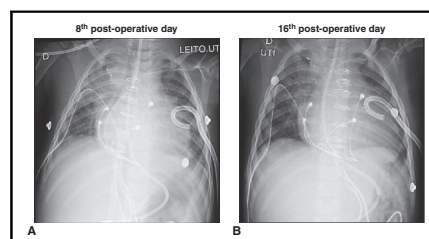
Here we describe the diagnosis and management of COVID-19 in a child with staged surgical palliation of hypoplastic left heart syndrome (HLHS). We believe this to be among the first reported cases of COVID-19 in a patient with CHD. This report was approved by the Research Ethics Committee of the Hospital Beneficência Portuguesa de São Paulo, and written informed consent was obtained from the patient's parents.

CASE DESCRIPTION

On March 24, 2020, a 35-month-old girl diagnosed with HLHS underwent a Fontan procedure with an 18-mm polytetrafluoroethylene tube and tricuspid valve repair (commissural plasty). The patient demonstrated complete atrioventricular block after cross-clamp removal,

necessitating temporary atrioventricular pacing, but regained a conducted sinus rhythm before leaving the operating room. In the intensive care unit (ICU), the patient was extubated and received metamizole and anticoagulants (heparin and enoxaparin) daily on the subsequent days, as part of routine postoperative care.

Her oxygen saturation worsened the day following the operation, with values <60% (Figure 1) with the onset of dyspnea and dry cough on postoperative day (POD) 2 (Figure 2). Echocardiography demonstrated low flow in the Fontan circulation, raising the suspicion of thrombosis in the Fontan circuit. Cardiac catheterization was performed, demonstrating no evidence of thrombosis and a patent fenestration. A left pleural effusion was noted, and a left pleural drain was placed to evacuate



Chest radiograph on postoperative day 9.

CENTRAL MESSAGE

COVID-19 could be a confounding factor for the diagnosis and management of patients with CHD. SARS-CoV-2 infection can progress with significant hypoxemia and mimics surgical complications.

See Commentaries on pages e103, e104, and e105.

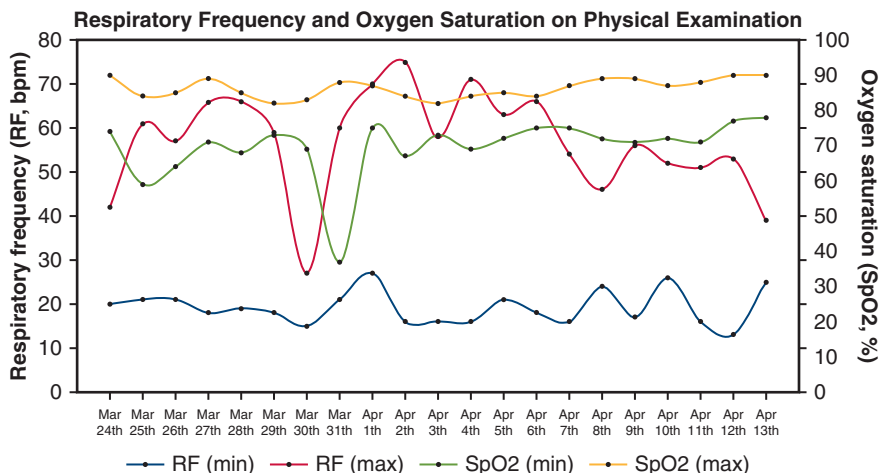


FIGURE 1. Respiratory frequency and oxygen saturation on physical examination. *Blue lines* represent the minimum and *red lines*, the maximum respiratory frequency; *green lines* represent the minimum and *yellow lines*, the maximum oxygen saturation.

it, without a significant improvement in oxygen saturation or tachypnea.

On POD 5, the patient began to experience intermittent complete atrioventricular block necessitating pacing. On POD 7, a permanent epicardial dual-chamber pacemaker system was implanted, positioned in the right atrium and right ventricle and with the generator in the upper abdominal wall. Following the surgery, the patient progressed with worsening hypoxemia,

with O₂ saturation dropping as low as 37%. Arterial blood gas tests showed a decrease in blood pH and inversion between O₂ and CO₂ partial pressures (Figure 3).

On POD 8, the patient began to have abdominal discomfort, followed the next day by respiratory distress and rare vomiting episodes (Figure 2). Milrinone, diuretics, and sildenafil were prescribed. A new chest radiograph showed multiple pulmonary consolidations, most evident on the

	FONTAN PROCEDURE AND TRICUSPID VALVE REPAIR							PACEMAKER IMPLANTATION							DISCHARGE FROM ICU						
Date	Mar 24 th	Mar 25 th	Mar 26 th	Mar 27 th	Mar 28 th	Mar 29 th	Mar 30 th	Mar 31 th	Apr 1 st	Apr 2 nd	Apr 3 rd	Apr 4 th	Apr 5 th	Apr 6 th	Apr 7 th	Apr 8 th	Apr 9 th	Apr 10 th	Apr 11 th	Apr 12 th	Apr 13 th
Post-Operative Day (POD)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Temperature (°C)	37.4	37.2	36.5	37.0	36.3	37.1	37.0	37.3	36.5	36.7	36.4	36.5	36.6	36.7	35.5	36.2	36.0	36.2	36.6	36.2	36.2
SaO2 min (%)	74	59	64	71	68	73	69	37	75	67	73	69	72	75	75	72	71	72	71	77	78
SaO2 max (%)	90	84	85	89	85	82	83	88	87	84	82	84	85	84	87	89	89	87	88	90	90
Cough																					
Fatigue																					
Vomiting																					
Abdominal Discomfort																					
Respiratory Support	OTI	HFO	HFO	HFO	NEB	OTI	OTI	OTI	NEB	NEB	NEB	HFO	HFO	HFO	HFO	NEB	NEB	NEB	NEB	NEB	NEB

OTI, Orotracheal Intubation; HFO, High Flow Oxygen (9-14 L/min); NEB, Oxygen Nebulization (5-10 L/min);

FIGURE 2. Historical timeline of the procedures and symptoms. On postoperative day (POD) 2, the patient began to show symptoms of COVID-19, with cough followed by hypoxemia, which necessitated orotracheal intubation on POD 5. After pacemaker implantation for atrioventricular block, the patient presented with new symptoms (fatigue, vomiting, and abdominal discomfort) and was submitted to high-flow oxygen therapy. She subsequently showed improvement and was discharged from the intensive care unit on POD 20. *ICU*, Intensive care unit.

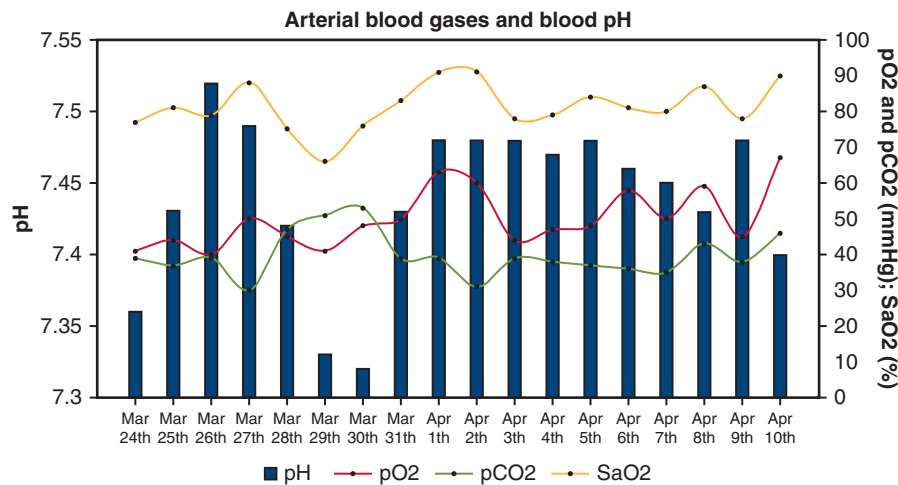


FIGURE 3. Arterial blood gases and blood pH. On postoperative day (POD) 7, the patient presented worsening of the hypoxemia, maintaining low blood pH and inversion between O₂ and CO₂ partial pressures.

upper third of the right lung (Figure 4, A). Laboratory tests revealed neutrophilic leukocytosis (leukocytes: 14,090 cells/mm³; neutrophils: 10,470 cells/mm³; lymphocytes: 2560 cells/mm³; Figure 5) and a C-reactive protein (CRP) value of 5.45 mg/L, which increased up to 11.36 mg/L on POD 12. Vancomycin and cefepime were initiated on POD 9.

The patient progressed with the worsening of cough on POD 10. On this day, the patient’s mother reported that she herself had anosmia, raising the concern that the child could possibly have COVID-19. Both parents reported flu-like symptoms starting a week before the date of the patient’s surgery. The patient was isolated, and a nasopharyngeal swab specimen was obtained and sent for the detection of viral respiratory pathogens.

On POD 11, the patient progressed with new onset of respiratory distress and worsening of hypoxemia, and high-flow O₂ was added to her respiratory support. The

intervention was successful in stabilizing her clinical parameters, and her general status improved over the next several days. On POD 13, reverse-transcription polymerase chain reaction of the nasopharyngeal swab confirmed COVID-19. The patient was removed from high-flow O₂ on POD 14 and maintained on oxygen nebulization. On POD 16, the patient continued to exhibit dry cough, but a chest radiograph showed reduction of the pulmonary consolidations with a sole remaining opacity in the upper third of the right lung (Figure 4, B).

Over the next several days, the patient improved. She was transferred from the ICU to the ward on POD 20, and from there to home on POD 24.

DISCUSSION

The present report, among the first to describe COVID-19 in a child with CHD, brings some interesting considerations (Figure 5). First, it highlights the importance of considering,

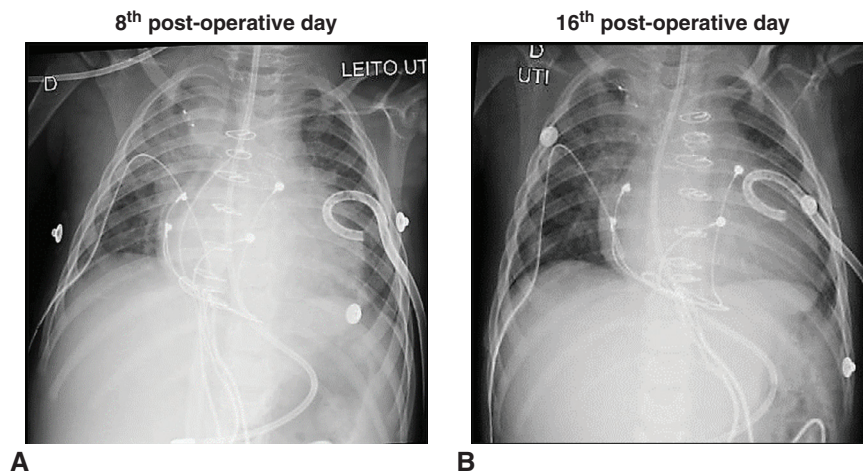


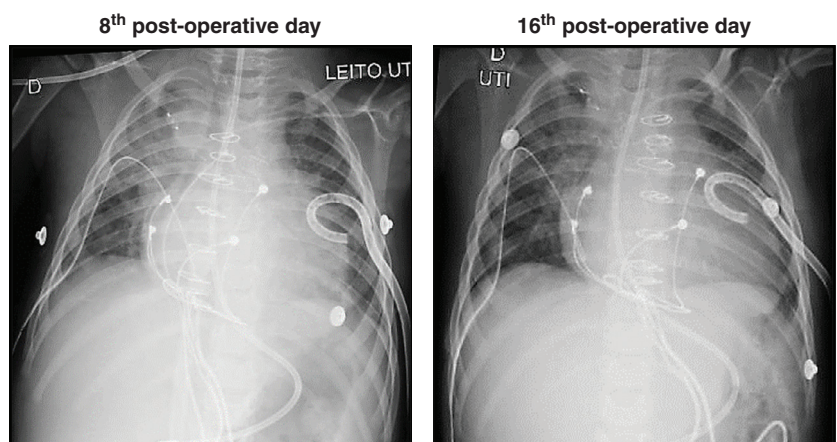
FIGURE 4. Chest radiography. A, On postoperative day (POD) 8, evidencing multiple pulmonary consolidations. B, On POD 16, showing a sole remaining opacity in the upper third of the right lung.

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Cough																					
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Respiratory Support	OTI	HFO	HFO	HFO	NEB	OTI	OTI	OTI	NEB	NEB	NEB	HFO	HFO	HFO	HFO	NEB	NEB	NEB	NEB	NEB	NEB

OTI, Orotracheal Intubation; HFO, High Flow Oxygen (9-14 L/min); NEB, Oxygen Nebulization (5-10 L/min);

A



B

TAKE-HOME MESSAGES

- COVID-19 could be a post-operative confounding factor in patients with CHD, mimicking surgical complications;
- Prescribed drugs may play a role in response to the infection;
- Pre-operative testing may play an important role in avoiding infected patients to be submitted to surgical procedures;
- Parents, siblings, and caregivers of children with CHD should practice prevention measures and engage in quarantine and social distancing.

C

FIGURE 5. Main outcomes and implications of the case. A, Historical timeline demonstrating the onset of COVID-19 symptoms following the surgical procedure. B, Chest radiographs from postoperative days 8 and 16, showing the recovery of pulmonary consolidations. C, Take-home messages from the case. *ICU*, Intensive care unit; *CHD*, congenital heart disease.

during a pandemic time, COVID-19 as a possible cause of complications in children with CHD, notably those recently submitted to surgical procedures. In these cases, it is commonly assumed that most complications are directly

associated with the disease or the procedure itself.⁴ However, particularly in complex cyanotic CHD, COVID-19 can progress with significant hypoxemia and mimic stenosis, kinks or thrombotic events. These findings could be also

described for other pneumonia, but considering the present situation, COVID-19 should be one of the first diagnostic hypothesis. Still, in the present case, COVID-19 did not greatly modify the outcomes, with the exception of prolonged ICU stay.

Second, it is crucial to understand how prescribed drugs may play a role in response to the infection. In this regard, at least 3 interactions must be highlighted in this case. The first involves the use of analgesic drugs with antipyretic effects, herein represented by metamizole but is also applicable to paracetamol, ibuprofen, and others. Such drugs could mask fever and delay infection diagnosis. On the other hand, it might contribute to prevent further worsening of the pneumonia. The second, the use of anticoagulants, is associated with decreased mortality in severe COVID-19 patients.⁵ In this regard, the subject patient was receiving anticoagulants, which could also have contributed to preventing the development of more serious disease manifestations.

Third, testing patients before surgery may play an important role in cases like the one reported here. The preoperative testing of children undergoing surgery for CHD has been proposed and has become standard in many services.^{6,7} Still, it might not be advisable or practical in all settings. In Brazil, for instance, where there is a queue of thousands of tests awaiting analysis by a limited number of laboratories, results are being released only slowly. If we opted to preoperatively test all children undergoing surgery for CHD, this prolonged waiting time could be detrimental for most of them. If any preoperative testing is

performed, the use of polymerase chain reaction–based testing of respiratory secretions is recommended. Another recommendation is to screen parents entering the hospital or clinic for both COVID-19 symptoms and contact with known positive cases.⁶ Despite these and other recently published recommendations, there are still no consensus guidelines for this emerging situation.

Finally, this case reinforces the importance of parents, siblings, and caregivers of children with CHD to practice primary infection control prevention and engage in quarantine and social distancing measures. These measures, particularly critical for all CHD patients, become even more relevant if the patient is expected to undergo a surgical procedure.

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