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CASE REPORT

ADVANCED

HEART CARE TEAM/MULTIDISCIPLINARY TEAM LIVE

Newborn With Severely Depressed Left Ventricular Function

Acute Myocardial Infarction in a Newborn

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ABSTRACT

We describe a rare case of spontaneous coronary artery thrombosis in a newborn leading to rapid severe ventricular dysfunction. Early diagnosis is critical and management strategies are varied including hemodynamic support with extracorporeal membrane oxygenation, systemic/local thrombolytic therapy with tissue plasminogen activator, or surgical thrombectomy. (**Level of Difficulty: Advanced.**) (J Am Coll Cardiol Case Rep 2020;2:1837–40)

HISTORY OF PRESENTATION

The patient was born via elective Cesarean section at 36 weeks gestation for maternal indication of placenta previa. The prenatal maternal history was significant for bleeding at 35 weeks of gestation and she was admitted to the hospital for monitoring and therapy with intravenous iron and vitamin B12. During admission, the fetal non-stress test was reassuring. Fetal echocardiogram demonstrated normal cardiac anatomy and function. Delivery was uncomplicated with Apgar scores of 9 and 9. At 2 h of life, the patient developed tachypnea, grunting, and cyanosis.

LEARNING OBJECTIVES

- To evaluate cardiogenic shock in a neonate with elevated cardiac enzymes and electrocardiogram changes concerning for myocardial ischemia should prompt evaluation of coronary arteries when no other etiology is immediately apparent.
- To recommend management of coronary thrombosis in a tertiary care center with availability of extracorporeal membrane oxygenation and a multidisciplinary team for reducing morbidity and mortality.

Initial oxygen saturation of 78% on the right foot and an oxygen saturation differential was observed with upper extremity saturation of 92%. Blood pressure was 58/31 mm Hg, heart rate was 147 beats/min, temperature was 36.6°C (97.9°F), and respiratory rate 85 breaths/min. Blood gas showed metabolic acidosis (pH 7.23, bicarbonate 17 mmol/l, base excess −10.0 mmol/l, lactate 7.3 mmol/l). Chest radiograph was notable for pulmonary plethora and bilateral hazy opacities concerning for pulmonary edema. In the setting of respiratory distress with differential cyanosis, the patient was transferred from newborn nursery to the neonatal intensive care unit with a subsequent screening bedside echocardiogram showing severely depressed left ventricular (LV) function.

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The authors attest they are in compliance with human studies committees and animal welfare regulations of the authors' institutions and Food and Drug Administration guidelines, including patient consent where appropriate. For more information, visit the *JACC: Case Reports* author instructions page.

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ABBREVIATIONS AND ACRONYMS

ECMO = extracorporeal membrane oxygenation

LV = left ventricular

QUESTION 1. WHAT IS THE DIFFERENTIAL DIAGNOSIS OF DEPRESSED FUNCTION WITH DIFFERENTIAL CYANOSIS IN A NEONATE?

Answer 1. Differential cyanosis refers to cyanosis in both lower extremities with a pink right upper extremity. This can be seen in newborns with patent ductus arteriosus and persistence of elevated pulmonary arterial hypertension leading to shunting of deoxygenated blood to lower half of the body. However, persistent pulmonary hypertension in a neonate is not typically associated with depressed LV function. Other differential diagnoses include left-sided obstructive lesions (aortic arch hypoplasia, interrupted aortic arch, critical coarctation, and critical aortic stenosis) which can present with depressed function and the cardiac output to the lower half of the body being supplied by the patent ductus arteriosus. Other possible causes included cardiomyopathy, myocarditis, and rare diagnoses of coronary artery abnormalities such as ostial stenosis/atresia, thrombosis, and dissection. Anomalous left coronary from the pulmonary artery can also present with depressed LV function usually within first few months of life as the pulmonary vascular resistance falls with associated coronary steal causing myocardial ischemia.

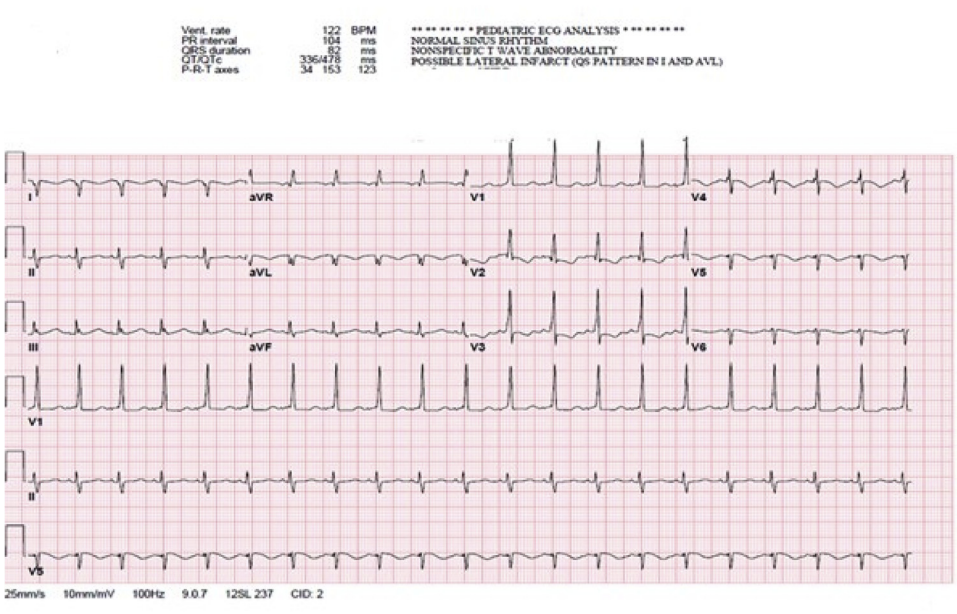
In the neonatal intensive care unit, cardiac markers were elevated with troponin (12 ng/ml) and creatine kinase myocardial band (135.6 ng/ml). The ECG showed a QS pattern in lead I and AVL concerning for lateral infarct (**Figure 1**). An echocardiogram showed severely depressed LV function (ejection fraction, 25%), moderate-to-severe mitral regurgitation, and no evidence of critical aortic stenosis or coarctation (Video 1). The clinical status, lactic acidosis, and troponin levels continued to worsen.

QUESTION 2. HOW WOULD YOU ACUTELY MANAGE THIS PATIENT?

Answer 2. Prompt recognition of cardiogenic shock is crucial and initial management included improving oxygen delivery to peripheral tissue with optimizing ventilation and gas exchange (oxygen therapy and intubation), optimizing pre-load and afterload with fluid resuscitation, diuretics, and inotropes (milrinone or dobutamine). It is also important to decrease oxygen consumption by treating for curable causes such as sepsis with broad spectrum antibiotics.

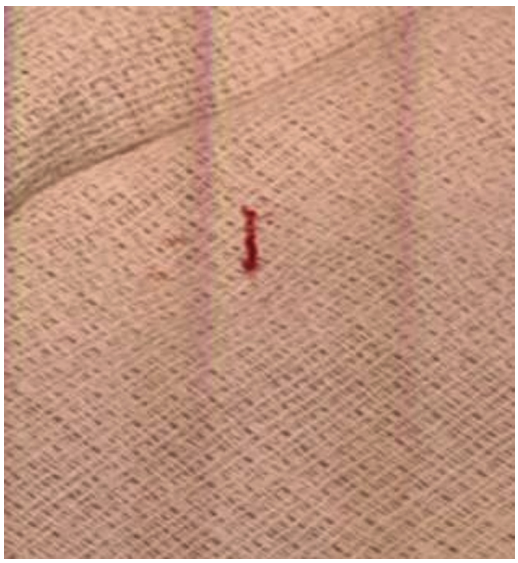
However, because of continued clinical deterioration with rising lactate levels and unclear etiology of

FIGURE 1 12-Lead Electrocardiogram



A 12-lead electrocardiogram showing QS pattern in lead I and lead AVL concerning for lateral infarct.

FIGURE 2 Thrombus



Thrombus measuring 0.9 × 0.1 × 0.05 cm retrieved from the left main coronary artery.

depressed LV function, the patient was cannulated on ventriculoarterial extracorporeal membrane oxygenator (ECMO) at 6 h of life. After being placed on ECMO, the patient underwent systemic heparinization.

QUESTION 3. WHAT ADDITIONAL INVESTIGATIONS DO YOU PROPOSE TO COMPLETE YOUR DIAGNOSIS AND WORKUP?

Answer 3. Detailed review of the echocardiogram revealed the normal origin of coronary arteries; however, a mobile echogenic focus in the aortic root close to the origin of the left coronary artery (Video 2) and antegrade flow in the proximal left main coronary were observed. Further assessment of the echocardiogram with focused imaging of the coronary artery suggested a membranous structure within the aortic root extending from the ostia of the left main coronary artery.

Based on these echocardiographic findings concerning for coronary thrombus versus aortic dissection, a cardiac catheterization was performed for better delineation of coronary anatomy. While the patient was on ECMO, an ascending aortic injection showed a non-occlusive thrombus in the left main coronary artery with a small degree of contrast passing above and below the thrombus with filling of the distal left anterior descending and circumflex (Video 3). The hematology department was consulted and a thrombophilia workup including prothrombin, partial thromboplastin, thrombin time, fibrinogen, as well as levels of antithrombin III, protein S and C were all within normal limits. Genetic screening for protein C, S, and factor V Leiden was negative. Because of clinical instability, evaluation of any other systemic thrombosis (renal/hepatic/ductus venosus) was not performed. No evidence of hemorrhage or ischemia was seen on head ultrasound.

These findings in conjunction with the continued elevated troponin levels despite full cardiac output support via ECMO suggested ongoing myocardial ischemia.

QUESTION 4. WHAT ARE THE RISK FACTORS FOR DEVELOPING CORONARY THROMBOSIS IN A NEONATE AND HOW WOULD YOU MANAGE IT?

Answer 4. Neonatal coronary thrombosis is a rare diagnosis and associated with significant morbidity and mortality from myocardial infarction and ischemia resulting in severe ventricular dysfunction. Prior suggested etiologies for coronary thrombosis in the structurally normal heart include hypercoagulability, prematurity, neonatal asphyxia, myocarditis, delayed cord clamping, paradoxical systemic emboli off the renal or placental vasculature through a patent foramen ovale into the left side of the heart, and placement of an umbilical venous catheter (1–3). In many cases, similar to this patient, no identifiable cause is detected. A common feature of all of these patients at presentation has been global ventricular dysfunction from ischemia causing "myocardial stun," a physiologically reversible process, especially in the neonatal myocardium (4). Earlier studies have reviewed the important role of hemodynamic stabilization with ECMO and association with long-term survival (5,6). In recent years, successful use of selective intra-coronary injection of recombinant tissue plasminogen activator has been described (7–9).

Others have reported surgical thrombectomy (10). In this case, because of rapid clinical deterioration and the use of ECMO for hemodynamic support and stabilization, the risk of life-threatening bleeding with recombinant tissue plasminogen activator in a fully heparinized patient outweighed the benefits, and the decision was made to proceed with surgical thrombectomy. The patient was taken to the operating room on day of life 1 where the aorta was transected distal to the sinotubular junction. A thrombus was identified in the left coronary cusp, extending into the left main coronary artery. The

thrombus was removed and the left coronary artery was subsequently probed without difficulty. The specimen was sent for pathology and was confirmed as dark red tissue resembling a blood clot and measuring 0.9 × 0.1 × 0.05 cm (**Figure 2**). Post-surgical thrombectomy the patient remained on ECMO and returned to the cardiac intensive care unit in stable condition.

QUESTION 5. HOW WAS THE PATIENT MANAGED POST-OPERATIVELY?

Answer 5. Over the course of the next 24 post-operative hours, both troponin and lactic acid levels improved. Additionally, elevated liver enzymes were noted, which were thought to be due to ischemic liver injury from severe cardiac dysfunction. Renal function was unaffected. ECMO course was uncomplicated and standard anticoagulation strategy with heparin was used with close titration to maintain activated clotting time of 180 to 200 ms. The patient underwent daily head ultrasounds while on ECMO as per protocol, and on day 6 of ECMO was noted to have very small area of hyperechogenicity in the right caudate nucleus measuring 0.5 × 0.8 × 0.7 cm, likely an area of hemorrhage and/or ischemia. Video electroencephalograph showed generalized background slowing with no electrographic or clinical seizures. On post-operative day 7, the patient was successfully decannulated from ECMO. Follow-up brain magnetic resonance imaging/magnetic resonance angiography/magnetic resonance venography showed right parietal subacute ischemic stroke, multifocal hemorrhage supra- and infra-tentorial, and no cerebral venous thrombosis. There was discussion to start anticoagulation with low-molecular-weight heparin for an unprovoked coronary thrombosis; however, given the concern for intra-cranial hemorrhage, the decision was made to hold off. Follow-up head ultrasound showed no change in findings.

The patient was discharged home on post-operative day 30 with mildly depressed LV systolic function (ejection fraction 48%). LV function has improved gradually 3 months post event with a normal ejection fraction of 56% (Video 4).

AUTHOR RELATIONSHIP WITH INDUSTRY

All authors have reported that they have no relationships relevant to the contents of this paper to disclose.

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KEY WORDS coronary artery thrombosis, myocardial ischemia, neonate

APPENDIX For supplemental videos, please see the online version of this paper.