

ILLUSTRATIVE CASE

Acute Cardiorespiratory Deterioration in a Preterm Infant

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CASE

A 31 and 1/7-week gestation premature male infant with a birth weight of 1730 g developed sudden onset of desaturations (oxygen saturation 30%), bradycardia (heart rate 40/min) and hypotension (mean blood pressure <15 mm Hg) at 6 days of age. He was born by a cesarean delivery for maternal preeclampsia, received nasal continuous positive airway pressure for 3 days after birth, and was in room air at the time of the acute event. On day 2 of life, a peripherally inserted central venous catheter (PICC) (L-Cath PICC Polyurethane catheter, 28 GA/1.2 F; Argon Medical Devices, Inc. Athens, TX) was inserted through the basilic vein in the right antecubital fossa to provide total parenteral nutrition. Catheter tip was located at the right atrium/superior vena cava (SVC) junction.

At the time of acute decompensation, the infant was resuscitated with bag and mask ventilation, endotracheal intubation, chest compressions, and administration of intravenous epinephrine through the PICC without improvement in his condition.

QUESTION: WHAT ARE THE CAUSES FOR POOR RESPONSE TO EFFECTIVE CARDIOPULMONARY RESUSCITATION?

When there is no significant change in the patient condition with cardiopulmonary resuscitation, providers should search for and treat possible contributing factors (H's: hypovolemia, hypoxia or hypercarbia, hydrogen ion (acidosis), hypo/hyperkalemia, hypoglycemia, hypothermia; and T's: toxins, tamponade (cardiac), tension pneumothorax, thrombosis, trauma).

Case Continuation

Endotracheal tube placement was confirmed by chest rise, auscultation, and tube position on chest radiograph. Pneumothorax was ruled out both clinically by transillumination and radiographically. Two normal saline fluid boluses were given. Bedside capillary blood gas measurement revealed severe acidosis but normal electrolyte and glucose levels. The chest radiograph demonstrated that the tip of the PICC was coiled within the right atrium (Fig 1). Due to poor response to resuscitative measures, a cardiac tamponade was suspected, consistent with the tip of the PICC line located in the right atrium.

QUESTION: WHAT IS THE NEXT STEP? HOW COMMON IS CARDIAC TAMPONADE IN THE NICU? HOW DO YOU TREAT IT?

Extravasation of intravenous fluids into the pericardial space leading to cardiac tamponade is one of the major life-threatening complications associated with the use of PICCs. The etiology of fluid entering the pericardial space

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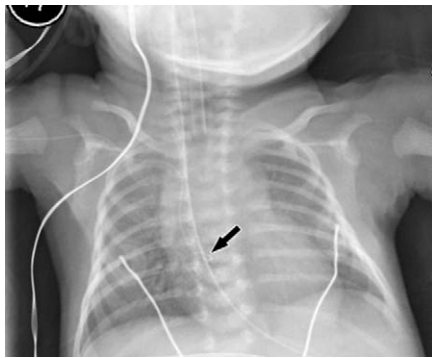


FIGURE 1 Tip of the PICC coiled within the right atrium (arrow).

is a result of perforation of the myocardium directly by the catheter tip or from tissue necrosis caused by hyperosmolar fluid.

In cardiac tamponade, pericardial pressures are elevated because of accumulation of fluid in the pericardial space. Once a critical level is reached, pericardial pressure rises rapidly and leads to severe cardiac compression. This results in inhibition of ventricular filling during diastole, elevated systemic and pulmonary venous pressures, and eventual compromised cardiac output and shock.

The incidence of cardiac tamponade as a complication of PICC placement is estimated to range from 0.1% to 1.8%.¹⁻⁴ A prospective cohort study of 19 NICUs in Japan over a 2-year period reported an incidence of 0.1%.¹ In a nationwide survey from Britain, the incidence of pericardial effusion or cardiac tamponade was 0.18%.² Nadroo et al³ reported an incidence of 0.76% in a single institution in the United States, and Pezzati et al⁴ reported an incidence of 1.8% in an 8-year retrospective review of 280 PICCs. A survey of NICUs in the United States revealed that 23% of NICUs have observed at least 1 death related to myocardial perforation or arrhythmia during the past 5 years.⁵

Even though cardiac tamponade as a complication of PICC placement is well described in neonatal medicine, this complication also can occur in older pediatric patients.^{5,6}

The clinical presentation of cardiac tamponade can be either acute cardiovascular collapse or subacute

cardiovascular instability, with a requirement for increasing inotropic or respiratory support. Classic clinical presentations of pericardial effusion or cardiac tamponade, such as jugular venous distension, pericardial rub, and pulsus paradoxus are not commonly detected in premature infants. Cardiomegaly may or may not be noted in the chest radiograph. Echocardiography is the mainstay of diagnosis, but is often not immediately available in acute circumstances. Urgent pericardiocentesis is the primary and only lifesaving treatment.

Nowlen et al⁷ reported the largest case series of central venous catheter–related pericardial effusions in infants to date. In this series of 61 pericardial effusions in infants secondary to central venous catheters, sudden cardiac collapse requiring cardiopulmonary resuscitation was reported in 37 cases (61%). No patients were reported to present with a rub or jugular venous distension, and only 2 patients were noted to have pulsus paradox. Median time from catheter insertion to detection of pericardial effusion was 3 days, consistent with our patient presenting 4 days after insertion. Heart size on chest radiograph was reported as qualitatively enlarged in only 25 cases (41%); in our patient, there was no evidence of increased cardiac size. Mortality was 8% (3 of 37) in patients who underwent pericardiocentesis versus 75% (18 of 24) in the patients who did not. Attempts to aspirate the effusion through the central venous catheter in 5 patients were made without success. There were no associations between central venous catheter types (silastic, polyethylene-polyurethane, polyvinyl) in either the mean days to occurrence or in the mortality rate. In 21 patients, the catheter was withdrawn and continued to be used.

Case Continuation

Emergency pericardiocentesis was performed with a 22-G spinal needle inserted subxiphoid at a 30-degree angle aimed at the left shoulder. Six milliliters of whitish fluid consistent with total parenteral nutrition fluid with lipids was drained. Rapid improvement in patient

condition was noted after the pericardiocentesis with vital signs returning to normal limits. The PICC was immediately withdrawn by 3 cm to relocate the catheter tip in the SVC. The PICC line was used for another 20 days without further complications. The patient was discharged from the hospital on day of life 45 with a normal neurologic exam and normal brain MRI, gaining weight on ad lib feeds.

QUESTION: HOW TO PREVENT THIS COMPLICATION?

Correct catheter tip placement after PICC insertion is very important to prevent pericardial effusion. In the case series from Nowlen et al,⁷ the catheter tip was last reported within the pericardial reflection in 92% of cases (82% within cardiac silhouette and 10% at vena cavae junction with right atrium). In our patient, the catheter tip was last reported at the right atrium-SVC junction. Arm movements are associated with significant displacement of the catheter tip,⁸ which highlights the need for continued surveillance of catheter position. Catheter tip position should be determined radiographically at the time of PICC placement. The tip of the PICC should be positioned outside the pericardial reflection line, which corresponds to a level above T2 on the chest radiograph (Fig 2). Serial radiographs should be performed to follow the catheter tip position and repeated after

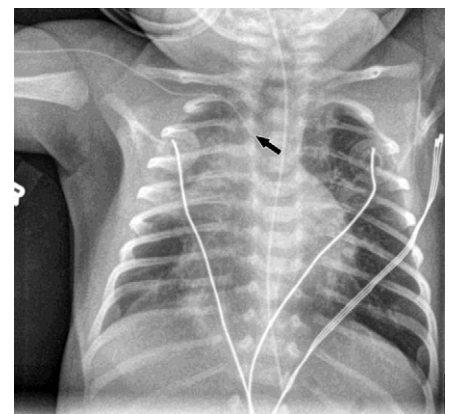


FIGURE 2 Chest radiograph demonstrating correct catheter tip position terminating in the SVC in the same patient after PICC line is withdrawn by 3 cm.

insertion and after repositioning to confirm proper placement.

QUESTION: WHEN AND HOW TO PERFORM PERICARDIOCENTESIS?

Pericardial effusion and cardiac tamponade always should be included in the differential diagnosis of any patient who develops acute or subacute cardiorespiratory decompensation in the presence of a PICC whenever the catheter tip is in the chest. Emergent pericardiocentesis should be strongly considered in any patient with an intracardiac PICC with sudden onset of cardiorespiratory instability who does not respond to the placement of an airway with delivery of effective ventilation and chest compressions.

Ideally, if time permits, pericardiocentesis can be performed under echocardiographic guidance using a pericardiocentesis kit in the hands of a pediatric cardiologist. Emergently, the next option is to perform the procedure using a spinal needle or intravenous canula, and enter the skin 0.5 to 1.0 cm below the tip of the xiphoid process, in the midline or slightly to the left of the midline. The needle should be at a 30- to 40-degree angle to the skin and the tip should be directed toward the left shoulder. The needle should be advanced until fluid is obtained.⁹

LEARNING POINTS

- Pericardial effusion and cardiac tamponade are rare but life-threatening complications of PICC insertion. Clinical presentation can be acute cardiovascular collapse or subacute cardiovascular instability.
- The tip of the PICC should be positioned outside the pericardial reflection line for prevention of this complication.
- Pericardial effusion and cardiac tamponade should be considered in a patient who develops cardiorespiratory decompensation in the presence of a PICC with catheter tip located in the chest. Emergency pericardiocentesis is lifesaving in such patients.

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