

Cardiac tamponade from peripherally-inserted central venous catheters in neonates: Three case reports

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SUMMARY

Pericardial effusion (PCE) and cardiac tamponade (CT) are rare but life-threatening complications of percutaneously-inserted central catheter (PICC) use in neonates. There is often a lack in index of suspicion in a neonate with sudden deterioration, resulting in high mortality. We describe a series of three cases of PICC-related PCE/CT in low birth weight infants whose timely diagnosis with echocardiography and pericardiocentesis led to successful resuscitation and survival. We suggest that echocardiographic skills to determine tip position and pericardiocentesis be taught in neonatal resuscitation programs to ensure good outcomes of this otherwise fatal complication.

INTRODUCTION

Peripherally-inserted central venous catheters (PICC) are routinely inserted in preterm infants for administration of total parenteral nutrition (TPN). Common complications include line-related sepsis, extravasation, migration of catheter and blocked lumen. Rarer complications include cardiac arrhythmias, pericardial effusion (PCE) and cardiac tamponade (CT). Incidence of CT associated with PICC is between 0.76 to 3.0% and results in high mortality of up to 50%.¹⁻³ From July 2017 to March 2020, there were three preterm neonates with PICC-related PCE/CT at the Department of Paediatrics, University Malaya Medical Centre (UMMC), Kuala Lumpur with no resulting mortality. All these three cases used the PICC from Vygon (Premicath size 1). We emphasize here on the importance of the position of the catheter tip and also explore ways to ensure its ideal placement. In low birth weight infants with PICC who present with sudden collapse, a high index of suspicion, early diagnosis of CT and prompt tapping can reduce mortality.

CASE REPORT

Case No. 1

A female infant was born at 30 weeks' gestation with a birth weight of 1120g. She was antenatally diagnosed with duodenal atresia. Amniocentesis was performed and karyotyping was normal. She was delivered preterm due to fetal distress and was stable at birth. To establish weight gain in preparation for reparative surgery, a PICC was inserted through the right basilic vein at day one of life. The catheter tip was reported to be at the cava-atrial junction from plain chest radiograph. The catheter had been in place for 13 days when the infant suddenly deteriorated with bradycardia and

desaturation. Cardiopulmonary resuscitation was performed for one hour. Bedside echocardiography showed the presence of cardiac tamponade. Percutaneous needle pericardiocentesis was performed in between chest compressions and a total of 26 ml of milky fluid was aspirated. The patient improved after pericardiocentesis. The PICC was immediately removed. Biochemical analysis of the fluid was consistent with TPN solution (Table I). Echocardiography done by the paediatric cardiologist the following day showed pericardial effusion mainly anterior overlying right ventricle around 5mm in deepest depth. Minimal effusion at the apex and posterior aspects was seen. No paradoxical right atrium or right ventricle collapse occurred. Poor left ventricular contractility was noted. A tiny patent foramen ovale was seen. A repeat echocardiography five days later showed resolution of pericardial effusion with normal ejection fraction of 78%. At eight weeks of life, the infant underwent duodenostomy and was discharged well at 12 weeks of life. The infant developed acute kidney injury associated with hypoxia due to cardiopulmonary collapse. She has chronic kidney disease and is under the monitoring of pediatric nephrology. The general physical and neurodevelopmental examination remained appropriate at three years corrected age.

Case No. 2

A male neonate was born at 31 weeks weighing 1560g. His mother presented in preterm labour and had a history of vaginal candidiasis two weeks earlier. He was stable at birth and required non-invasive ventilation support. The neonate developed necrotizing enterocolitis at day five of life and was kept nil by mouth. PICC was inserted for nutritional support. The PICC was sited at the left anterior cubital fossa and tip position was confirmed by chest X-ray. Five days later, the condition of the infant unexpectedly deteriorated. He was intubated and bedside echocardiogram performed showed cardiac tamponade. The infant collapsed during preparation for pericardial tapping and cardiopulmonary resuscitation was commenced. Return of spontaneous circulation was achieved after 30 minutes of cardiopulmonary resuscitation. Percutaneous needle pericardiocentesis was performed and 11ml of cloudy fluid was aspirated. The PICC was removed immediately. The fluid from the pericardial sac appeared turbid with fluid biochemistry consistent with TPN components (Table I). Echocardiography was repeated the following day showing normal heart structures with good biventricular function. Tiny pericardial effusion was seen next to the right ventricle. The infant was discharged well at day 33 of life and remained well at 12 months corrected age.

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Table II: Score summary of MBI, IADL, EVS & O&M assessment at baseline and at 3 months visit

Case	Duration of onset of PCE	Observed PICC Tip position on chest x-ray	Type of Infusate through PICC	Pericardial Fluid Biochemistry				
				Triglyceride (mmol/L)	RBCs (uL)	WBCs (uL)	Glucose (mmol/L)	Protein (g/L)
1	14 days	Cavo-atrial junction	TPN, lipid	6.2	410	80	73.7	3.03
2	5 days	Right atrium	TPN, lipid, Cloxacillin, Amikacin	5.7	10	0	84.1	<0.01
3	2 days	Right atrium and adjusted to cavo-atrial junction	TPN, lipid, Penicillin, Gentamicin	3.3	39	3	45.4	3.3

PICC- peripherally-inserted central venous catheters; PCE- pericardial effusion; TPN- total parenteral nutrition

Case No. 3

A male infant was born at 30 weeks' gestation with a birth weight of 1090g. He was delivered premature due to maternal pre-eclampsia, intra-uterine growth restriction and abnormal Doppler. At day four of life, PICC was inserted at the right anterior cubital fossa. Chest radiograph post insertion showed the tip of PICC in the right atrium. The line was therefore re-sited to the cavo-atrial junction. The infant developed recurrent apnoea requiring intubation by 48 hours post procedure. Antibiotics were started to cover for sepsis. Persistent tachycardia with muffled heart sounds heralded the suspicion of pericardial effusion, confirmed via bedside echocardiography. An ultrasound-guided percutaneous needle pericardiocentesis was immediately performed and a total of 6ml of serous fluid was aspirated. The PICC was removed immediately. Biochemistry findings was consistent with TPN fluid. Ten days later, echocardiography showed resolution of pericardial effusion. Patent foramen ovale was seen. The patient was discharged well at day 53 of life, with good neurodevelopmental outcomes during subsequent follow-up assessments.

DISCUSSION

The incidence of PICC-related PCE/CT were reported to be between 0.4 to 3%.^{1,3} The incidence at UMMC was 1.5%. Although rare, early suspicion and detection are crucial due to its high mortality rate of up to 50%.¹ Our case series demonstrated expeditious diagnosis of PCE/CT and rapid therapeutic intervention, resulting in good outcome of survival and good prognosis in all three cases. Having immediate access to an ultrasound machine where echocardiography could be performed quickly also aided in establishing the diagnosis early.

In preventing PICC-related PCE/CT, position of the tip of catheter is of utmost importance. It is recommended for the tip of catheter to be placed outside the cardiac chambers, at the junction of superior or inferior vena cava and right atrium, by 0.5-1cm for premature infants, and by 1-2cm in term infants on the chest radiograph.^{4,6} Studies have shown that the catheter tip can migrate towards the heart with any movement of the limb and the risk for pericardial effusion is up to 80 to 90% if the tip is within the pericardial reflections on the chest radiograph.^{2,3,6-8} Due to frequent catheter migration, Nadroo et. al. recommended serial radiographs twice a week as long as a PICC is in use.² In UMMC, plain AP radiograph is routinely used to confirm the position of PICC

tip. Acceptable positions of tip of catheter were the cavo-atrial junction or the right atrium. The first two cases had the tip of catheter within the cardiac silhouette and in the third case the tip was at the cavo-atrial junction.

However, AP chest radiograph was found to have low sensitivity and specificity, at 32% and 89% respectively with significant inter-observer variability.^{6,9} In case 1, the tip of catheter was reported by to be at the cavo-atrial junction but was found to be within the cardiac silhouette upon review after the incident. A study found that of all lines interpreted to be in the right atrium or atrial/inferior vena cava junction using AP chest radiograph, 60% were found to be in the left atrium by echocardiography.⁹ Echocardiography has been recommended as the best modality as it provides precise information regarding the tip position.^{6,9,10} However, it is technician dependent and difficult to perform due to small body size of premature infants,¹⁰ and an experienced neonatologist may not be present at the time of emergency.

In conclusion, any preterm infant with PICC who presents with unexplained sudden deterioration should have an echocardiogram performed by an experienced clinician to diagnose PCE/CT. Expeditious pericardiocentesis will avoid sudden death. Conversely, as the condition is rare, sufficient skills in determining PCE/CT and performing pericardiocentesis may not have been acquired. Therefore, patient safety demands for the following essential measures: (1) Reinforcement of echocardiographic skills to detect pericardial effusion and to determine PICC tip positions. (2) The integration of pericardiocentesis skills be taught in simulation modules in neonatal resuscitation programs.

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REFERENCES

- Beardsall K, White D, Pinto E, Kelsall A. Pericardial effusion and cardiac tamponade as complications of neonatal long lines: are they really a problem? *Arch Dis Child Fetal Neonatal* Ed 2003; 88(4): F292-5.
- Nadroo AM, Lin J, Green RS, Magid MS, Holzman IR. Death as a complication of peripherally inserted central catheters in neonates. *J Pediatr* 2001; 138(4): 599-601.
- Nowlen TT, Rosenthal GL, Johnson GL, Tom DJ, Vargo TA. Pericardial effusion and tamponade in infants with central catheters. *Pediatrics* 2002; 110(1): 137-42.

Case Series

4. Department of Health (UK). Review of deaths of four babies due to cardiac tamponade associated with previous central venous catheter. 2001.
5. Yoder D. Cardiac perforation and tamponade: the deadly duo of central venous catheters. *Int J Trauma Nurs* 2001; 7(3): 108-12.
6. Sneath N. Are supine chest and abdominal radiographs the best way to confirm PICC placement in neonates? *Neonatal Network*. 2010;29(1): 23-35.
7. Weil BR, Ladd AP, Yoder K. Pericardial effusion and cardiac tamponade associated with central venous catheters in children: an uncommon but serious and treatable condition. *JPediat Surg* 2010; 45(8): 1687-92.
8. Fischer GW, Scherz RG. Neck vein catheters and pericardial tamponade. *Pediatrics* 1973; 52(6): 868-71.
9. Ades A, Sable C, Cummings S, Cross R, Markle B, Martin G. Echocardiographic evaluation of umbilical venous catheter placement. *JPerinatol* 2003; 23(1): 24-8.
10. Ohki Y, Maruyama K, Harigaya A, Kohno M, Arakawa H. Complications of peripherally inserted central venous catheter in Japanese neonatal intensive care units. *Pediatrics International* 2013; 55(2): 185-9.