

Survival After an Acute Pericardial Tamponade as a Result of Percutaneously Inserted Central Venous Catheter in a Preterm Neonate

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Abstract. Percutaneously inserted central venous catheters (PICC) are used in premature infants to deliver intravenous fluids, total parenteral nutrition (TPN) and medications. This article reports a case in which the baby developed pericardial tamponade within 3 hours of starting TPN through a PICC. This was successfully treated with percutaneous subxiphoid pericardiocentesis. Pericardial tamponade should be suspected in any infant with a PICC line in place, and who suddenly develops shock like symptoms, non-attributable to usual causes.

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Key words : PICC lines-complications; Pericardial tamponade; Pericardiocentesis; Premature infant

Placement of a percutaneously inserted central venous catheter (PICC) has been used in neonates since the 1970s. Shaw was one of the first to report the use of a PICC for intravenous therapy in neonates requiring prolonged total parenteral nutrition (TPN).¹ Later on many neonatal intensive care units introduced this procedure.^{2,7} Complications associated with the use of central venous catheters are sepsis, haemorrhage, thromboembolism and catheter dislodgment.^{2,5-7} Complications due to malpositioning of the central venous catheter include cardiac arrhythmias, hydrothorax and pericardial effusion with cardiac tamponade. In the past, catheters were made of stiff plastic, often polyethylene.^{2,5-7} It was thought that, with the advent and use of softer and more supple silastic catheters, these complications could be minimised.⁴ However several recent reports have shown that potentially fatal complications can result from the use of silastic catheters as well.^{4,6,8,9} A literature review demonstrated that in the majority of cases, which are complicated by a pericardial effusion after insertion of a PICC line; the presentation was more than 48 hours after insertion.¹⁻¹⁴ The shortest time interval between the insertion of catheter and development of cardiac tamponade in literature is a little more than 24 hours.¹⁰ We report this unusual case in which the baby

developed pericardial tamponade secondary to pericardial effusion 3 hours after the commencement of infusion of TPN through a PICC.

CASE REPORT

A 774-gram female neonate, the result of a 26-week twin gestation, was delivered by caesarean section because of uncontrolled hypertensive disease in the mother. The infant was intubated at birth and received surfactant. She was ventilated for hyaline membrane disease and the nursery course was otherwise uncomplicated.

A PICC (Percutaneous Silastic catheter-2 Fr Per-Q-Cath®, Bard Access systems, Salt Lake City, UT) was inserted electively on day 7 of life through the basilic vein in the left cubital fossa to provide nutritional support and medications. The distance of the catheter to be inserted was determined by measuring the distance between the insertion site and the desired catheter tip position (at the junction of the superior vena cava and right atrium). A chest X-ray performed to check the position of the catheter, which was not a very good quality film, showed that the catheter tip was probably located in the right atrium. Three hours after commencing the infusion of parenteral nutrition and lipid through the PICC, the infant deteriorated dramatically with severe bradycardia (heart rate 20/min), hypotension (mean blood pressure <10 mm of

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Hg) and desaturation (oxygen saturation of 30%). There was no evidence of ventilator malfunction, endotracheal tube blockage or pneumothorax (transillumination). The chest movements were equally good on both sides, with the on-line pulmonary graphics showing adequate tidal volumes. The blood gas showed hypoxia but no respiratory acidosis. Having clinically excluded likely causes, the possibility of pericardial tamponade related to PICC was considered and subxiphoid percutaneous pericardiocentesis was performed with a 20G cannula attached to a 10 ml syringe which resulted in aspiration of 3.5 ml of milky white fluid. The clinical response to pericardiocentesis was rapid with recovery of the heart rate, blood pressure, and oxygen saturation to normal within 2 minutes of the procedure. The fluid from the pericardial sac was later confirmed by biochemical analysis to be parenteral nutrition fluid and lipid. An echocardiogram performed immediately after draining the pericardial fluid showed that there was minimal residual pericardial fluid, and the PICC catheter was traced to be passing through the right atrium, in to the right ventricle, however its tip was not visualised properly. A repeat chest X-ray showed that the catheter tip was located in the right ventricle (Fig. 1). The catheter was withdrawn by 5 centimetres to relocate its tip in the superior vena cava. The PICC line was used for the next two weeks for TPN and medications without any other incident, and was withdrawn electively when the infant was established on enteral feeds. She was ventilated for a total of 14 days and was oxygen dependent at the time of transfer

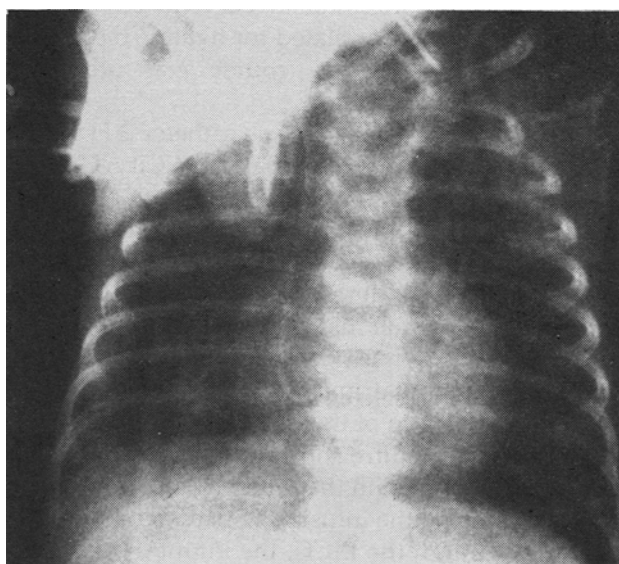


Fig. 1. Chest X-ray showing the PICC catheter tip located in the right ventricle

(day 84 of life) to a level II NICU. Several serial head ultrasound examinations including the one at 2 months after this episode were normal. The growth, general physical and neurodevelopmental examination was appropriate for age at the time of last review at 11 months of corrected age.

DISCUSSION

Pericardial tamponade should be considered immediately in any infant with a PICC line in place who has a rapid onset of bradycardia, hypotension, desaturation, congestive heart failure and cardiac arrest. This is particularly important where the cardiovascular deterioration is not associated with a preceding respiratory deterioration. Pericardial tamponade is a rare but serious life threatening complication of PICC use. The mortality rate of pericardial tamponade has been reported to be as high as 67 per cent.¹² Often the diagnosis is considered too late for intervention, or is not considered at all.¹⁻¹⁴

A review of 16 cases (including a case at Dept. of Neonatology, University of Sydney) of CVC either use resulting in pericardial tamponade in very low birth weight babies showed that there was TPN infusing through all of the catheters and in the majority of patients, insertion of the line was performed more than 48 hours before tamponade occurred.¹⁻¹⁴ The shortest time interval between the insertion of a catheter and development of cardiac tamponade in the literature was little more than 24 hours.¹⁰ Our patient differed from others described in the literature, presenting only 3 hours after commencement of the TPN and lipid infusion through the line.

The volume of fluid drained by pericardiocentesis in our patient was 3.5 ml, and there was still some residual fluid in the pericardial sac after the pericardiocentesis, demonstrated on echocardiography. The question is can this small amount of fluid cause pericardial tamponade? Agarwal *et al*¹⁴ have reported a case of pericardial tamponade in a 24-week premature infant with birth weight of 630 gram, secondary to PICC line. This infant had a PICC line inserted on day 3 of life, had unexplained deterioration and death on day 6 of life. Autopsy showed a pericardial effusion, a total of 5ml of fluid was aspirated from the pericardial cavity, compared to the heart weight of 4.4 gram, and this amount was thought to be significant enough to interfere with cardiac filling. Based on findings in our case and the case discussed by Agarwal *et al*¹⁴, we conclude that even a small amount of effusion can cause significant cardiac tamponade in preterm infants because of their smaller heart size.

Survival After an Acute Pericardial Tamponade

The exact mechanism of pericardial effusion with PICC use remains uncertain. Catheters placed initially in the superior vena cava can, with the respiratory and cardiac movements or movement of the infant's head/trunk or arm, migrate deeper into the right atrium or right ventricle and lodge against or perforate the atrial/ventricular walls. In some reported cases in the literature the catheter had migrated into the heart and perforation through the myocardium was noted on autopsy examination.^{3,5,11} When no perforation is visualised, it has been hypothesised that the pericardial effusion may result from the hypertonic TPN solution, causing tissue damage at the site where the catheter tip is lodged against the right atrial/ventricular wall. Autopsies performed on seven infants who died following cardiac tamponade demonstrated denuded endocardium with thrombosis and myosclerosis at the site where the catheter tip came in to contact with the atrial or ventricular wall. TPN and lipids can then transude through the damaged endocardium in to the pericardial sac.¹⁰

A task force convened by the Food and Drug Administration (FDA) of the United States of America and representatives of health profession organizations including the American Academy of Paediatrics (AAP), has made recommendations regarding the use of PICCs.¹⁵ The recommendations are pertinent to all central venous catheters, including the PICCs : they include "the catheter tip position should be confirmed by X-ray or other imaging modality and re-checked periodically". Based on these FDA recommendations,¹⁵ the experience of professionals involved in the care of newborn world wide,¹⁻¹⁴ and our own experience, we suggest the following guidelines :

1. Position the catheter tip in the superior vena cava (SVC) proximal to the SVC/RA (right atrium) junction if inserted through arm or head veins. Position the catheter tip in the inferior vena cava (IVC) just distal to IVC/RA junction if inserted through one of the leg veins. Do not place or allow the catheter tip to migrate in to the heart.
2. Determine the catheter tip position by chest X-ray at the time of catheter placement. An injection of 0.3 to 0.5 ml of water-soluble radiopaque contrast media (eg. Isovue 200, Bracco Pharmaceuticals) just prior to the X-ray being exposed may be used to visualise the catheter tip if there is a question about catheter tip position. This may be necessary even with radiopaque catheters because of difficulty in visualising the tip of the catheter on plain X-ray.
3. Checking the position of the catheter tip periodically (once or twice weekly) by chest X-ray looking for catheter migration or displacement into the right atrium or right ventricle.

4. Note the position of the catheter tip on all X-rays taken for other clinical reasons.
5. Immediately stop the infusion of fluids into the catheter if pericardial effusion with tamponade is suspected. Extra volume should not be given through the PICC unless the pericardial effusion is first excluded.
6. Consider pericardiocentesis as a part of the resuscitation procedure in any infant with a PICC who develops sudden unexplained bradycardia, desaturation, hypotension, and cardiac arrest, particularly if not preceded by a respiratory deterioration.
7. Remove the PICC when it is no longer required for nutritional support or medications.

In summary, pericardial tamponade should be considered in any newborn with a PICC who experiences a rapid deterioration presenting as bradycardia, hypotension, hypoxia and cardiac arrest not attributable to the usual causes. If a pericardial effusion is suspected, and echocardiography is available in the intensive care unit, it could be performed immediately to rule out this rare but treatable complication. Otherwise a subcutaneous subxiphoid pericardiocentesis performed at the bedside relieves the symptoms immediately. Echocardiographic guidance of the procedure may be utilised if available.

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