CASE REPORT

Umbilical artery perforation: a potentially life-threatening complication of umbilical artery catheterisation

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SUMMARY

Umbilical artery catheterisation is frequently performed in preterm or critically ill newborn infants for invasive monitoring of blood pressure and blood sampling for laboratory tests. It is associated with well-known complications like catheter-related infections, thromboembolic events and aneurysmal formation of the aorta. In this report, we present another major complication of umbilical artery catheterisation: umbilical artery perforation. This complication occurred in a prematurely born infant and resulted in severe haemorrhagic shock, subsequent renal failure and severe periventricular leukomalacia. Ultimately, the patient deceased 3 weeks after birth. Review of the literature identified only a few case reports and retrospective postmortem studies describing this complication. Neonatologists and paediatricians performing umbilical artery catheterisation should be aware of this rare, but potentially life-threatening complication.

BACKGROUND

The procedure of umbilical artery catheterisation in neonates was first described in 1962 and has shown its benefit in preterm and critically ill neonates, in whom invasive monitoring of blood pressure is indicated and/or frequent blood sampling is required.¹ However, it is also associated with several complications, including catheter-related infections, aneurysmal formation of the aorta and/or other great vessels and thromboembolic events.²⁻³ These complications have high morbidity and mortality rates. In this article, we present a case report and a review of literature about a rare, but potentially life-threatening complication of umbilical artery catheterisation: umbilical artery perforation.

CASE PRESENTATION

The patient was a male newborn infant of a 34-year-old mother, who was gravida 3, para 1. The pregnancy was complicated by cervical insufficiency and premature birth at a gestational age of 27 weeks. His weight at birth was 1245 g. Corticosteroid therapy and magnesium sulfate were administered perinatally to improve lung development and provide neuroprotection, respectively. Nasal continuous positive airway pressure was given immediately after birth to support respiration. The Apgar scores were 5, 9 and 9 after 1, 5 and 10 min,

respectively. The child was admitted to our level III neonatal intensive care unit after birth.

After admission, arterial access was indicated for invasive monitoring. During the first attempt to insert an umbilical artery catheter (Vygon Umbilical catheter single lumen 3.5 Fr) into the umbilical artery, the catheter was advanced easily to a distance of approximately 5 cm. However, at that point, resistance was felt and blood could not be retrieved, suggesting malposition of the catheter. The catheter was removed and the other umbilical artery was used for inserting a new catheter. This time, the catheter was advanced to the estimated appropriate position and blood could be drawn, confirming the intravascular position. Subsequently, an umbilical venous central catheter was inserted without complications. An abdominal X-ray was performed to verify the correct position of the catheter tips. During this period, the patient showed mild respiratory distress and oxygen dependency. To increase his lung volume, he was placed in prone position after the procedure. Twelve hours later, the position of the child was changed to supine position. Shortly after that, the patient deteriorated with respiratory insufficiency and signs of hypovolemic shock, including paleness, tachycardia, prolonged capillary refill and hypotension. Laboratory findings showed a dramatic decrease of haemoglobin level from 16.9 to 2.9 g/dL. Also, severe lactate acidosis and disrupted haemostasis were observed (table 1). Ultrasound examination of the abdomen showed a periumbilical haematoma and fluid in the peritoneal cavity.

TREATMENT

Circulatory support with repetitive fluid bolus, erythrocyte transfusions and inotropic treatment was given. High-frequency oscillatory ventilation was initiated for respiratory support. Despite intensive haemostasis therapy, including frequent vitamin K, thrombocyte and fresh frozen plasma transfusions, the bleeding continued. A laparotomy revealed a longitudinal perforation of the right umbilical artery 4 cm below the umbilical entry. The right umbilical artery was used during the first attempt to insert an umbilical artery catheter, confirming the diagnosis of iatrogenic perforation of the umbilical artery due to catheterisation. Blood was observed in the peritoneal cavity, as well as in the extraperitoneal space. The lesion was surgically

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Table 1 Laboratory findings before and 12 hours after perforation of the umbilical cord artery by catheterisation

	Reference values	Before procedure	12 hours after procedure
Haemoglobin	13.7–20.1 g/dL	16.9 g/dL	2.9 g/dL
Thrombocytes	>150× 10 ⁹ /L	275× 10 ⁹ /L	67× 10 ⁹ /L
APTT	25–40 s	NA	130 s
Prothrombin time	0.80–1.20 INR	NA	4.43 INR
pH	7.33–7.49	7.21	7.03
pCO ₂	26–41 mm Hg	65 mm Hg	34 mm Hg
HCO ₃ ⁻	16.0–24.0 mmol/L	25.0 mmol/L	8.7 mmol/L
Base excess	-10.0 to 2.0 mmol/L	-4.9 mmol/L	-21.3 mmol/L
Lactate	<2.2 mmol/L	NA	16.0 mmol/L

APTT, activated partial thromboplastin time; INR, international normalised ratio; NA, not available.

closed by ligation of the umbilical artery proximal and distal of the perforation, which resulted in rapid haemostasis.

OUTCOME AND FOLLOW-UP

During a period of 19 hours, starting from the moment of the first signs of hypovolaemic shock the patient was anuric and creatinine levels increased rapidly. Ultrasound imaging of the kidneys initially showed swollen kidneys followed by severe renal cortical necrosis. He developed end-stage renal disease in the subsequent weeks, which required renal replacement therapy. However, haemodialysis was not an option because of premature age and low birth weight and peritoneal dialysis was not possible due to recent abdominal surgery. Furthermore, ultrasound imaging of the brain also showed marked dilated ventricles and periventricular leukomalacia grade 1. Due to the poor neurological prognosis and absence of treatment options for end-stage renal disease, treatment was withdrawn after extensive discussion among neonatologists, paediatric nephrologists, paediatric neurologists and parents. The patient deceased at the postconceptional age of 30 weeks and 3 days.

DISCUSSION

Catheter-related infections, aneurysmal formation of the aorta and/or other great vessels and thromboembolic events are well-known complications of umbilical artery catheterisation.^{2,3} The vascular complications can be mild and transient. For example, a patient can have blue toes for a few hours or have renovascular hypertension. However, these complications can also cause severe and permanent damage to organs and/or limbs and even result in death of the patient. Peripheral artery catheterisation of the radial artery or the posterior tibial artery is an alternative procedure to umbilical artery catheterisation. However, due to the small size of these arteries, this procedure is associated with vascular complications in the distal extremity and can result in limb gangrene.² This is especially a problem in preterm infants or low birthweight infants. Furthermore, due to the smaller lumen of the peripheral artery catheter, it tends to occlude more easily compared with the larger umbilical artery catheter. Consequently, umbilical artery catheterisation is the preferred procedure in preterm and critically ill newborn infants, in whom invasive monitoring of blood pressure is indicated and/or frequent blood sampling is required.

Review of literature confirmed the rare occurrence of iatrogenic perforation of the umbilical artery by catheterisation. We could only find three case reports and two retrospective cohort studies describing this complication.^{3–7}

Miller *et al* showed that perforation of the umbilical artery predominantly occurs at the annulus umbilicalis or near the exit of the umbilical artery from the hypogastric artery,⁴ which are located 1–2 cm and 5–6 cm from the anterior abdominal wall, respectively. The umbilical arteries are vulnerable at these points because of the change of course of the artery and also because luminal narrowing due to endothelial cushions is maximal at these sites. Risk factors for umbilical artery perforation were multiple attempts to place an umbilical artery catheter and insertion against resistance.⁴ In our case, we performed two attempts, one at each individual artery. Although resistance was felt after inserting the first catheter at 5 cm, we did not try to advance the catheter. Unfortunately, this still had resulted in a lesion 4 cm from the abdominal wall as was identified during surgery.

Presenting signs of an umbilical artery perforation include signs of circulatory insufficiency, such as pale colour, tachycardia, increased capillary refill and hypotension in combination with signs of blood accumulation into the peritoneal cavity or extraperitoneal space like abdominal distention, lower abdominal wall induration and ecchymosis.⁴ Surprisingly, the first signs of abdominal blood loss in our patient were observed 12 hours after the procedure. In retrospect, we hypothesise that the prone position, in which the infant was placed after insertion of the umbilical catheters, caused sufficient pressure on the umbilical artery, resulting in tamponade of the lesion. After repositioning the child to supine position, his clinical condition rapidly deteriorated. This was probably due to the relieve of pressure on the umbilical artery, resulting in extensive blood loss. Early laboratory abnormalities included a marked drop of haemoglobin level, metabolic acidosis and prolonged haemostasis. Ultrasound imaging can confirm diagnosis with signs of periumbilical haematoma and/or accumulation of blood in the peritoneal cavity and/or extraperitoneal space. However, we underline that ultrasonography should not delay initiation of treatment because timely intervention is essential for the prognosis of these patients. Other imaging techniques are not indicated.⁴

Treatment consisted of intensive circulatory, haemostatic and respiratory support followed by surgical closure of the perforation. Surgical intervention is required in most cases because perforation by catheterisation causes a longitudinal lesion, which prevents effective contraction of the artery and spontaneous closure of the lesion. Also, review of literature shows that the few patients who survived an iatrogenic perforation of an umbilical artery underwent surgical intervention.^{4,6}

Outcome differs among patients and depends on pre-existent condition and severity of blood loss, which is directly related

Learning points

- ▶ Perforation of the umbilical artery by catheterisation, although rare, is still relevant to current practice.
- ▶ Every paediatrician or neonatologist performing this invasive procedure should be aware of this life-threatening complication, especially when multiple attempts are performed, resistance is felt or signs of circulatory insufficiency develop after insertion.
- ▶ Clinical examination, laboratory findings and abdominal ultrasound can confirm diagnosis.
- ▶ Early recognition and timely intervention, using intensive respiratory and circulatory support as well as haemostasis therapy, including surgical closure of the lesion are crucial to improve the prognosis of these patients.

to the size of the lesion, time of recognition and initiation of treatment. Although Sasidharan described a patient with full recovery, other reports indicate that most patients do not survive umbilical artery perforation.^{3–7} To improve outcome for any future patients, we have altered our standardised procedure protocol for umbilical artery catheterisation. To identify early signs of umbilical artery perforation, all patients should lie in supine position without coverings during the first hours after the procedure, especially when multiple attempts were made and/or when insertion against resistance was felt. Furthermore, blood sampling and/or abdominal ultrasound should be done without delay in case of suspected umbilical artery perforation.

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