

VIDEOS IN CLINICAL MEDICINE

Umbilical Vascular Catheterization

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N Engl J Med 2008;359:e18.

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INTRODUCTION

Peripheral blood vessels in neonates are often friable and difficult to access, particularly in the preterm population, and traditional central venous catheters are both challenging and risky to place. For this reason, umbilical-artery catheters (UACs) and umbilical-vein catheters (UVCs) are used to provide much-needed access for resuscitation, frequent monitoring of blood, administration of fluids, blood transfusion, and parenteral nutrition in neonates whose condition is unstable. Placement of umbilical catheters is an important skill in the treatment of critically ill neonates.

INDICATIONS

Umbilical-vessel catheters are indicated for use in neonates in unstable condition, including those who require frequent monitoring of blood gas, more than 40% oxygen, continuous monitoring of blood pressure, administration of high-osmolality fluids such as parenteral nutrition, or emergency vascular access. Umbilical-vessel catheterization may be indicated when attempts to obtain peripheral access are unsuccessful.

CONTRAINDICATIONS

The contraindications are similar for the umbilical arteries and the umbilical vein. These include omphalocele, gastroschisis, omphalitis, and peritonitis. In umbilical-artery catheterization, evidence of vascular compromise in the lower limbs or buttocks and necrotizing enterocolitis are considered additional relative contraindications.

PREPARATION

Umbilical-vessel catheterization is performed with the neonate placed in the supine position, with arms and legs restrained if possible. Begin by ensuring strict sterile technique. Determine the size and type of catheter to be used. A 5-French UAC should be used for infants weighing 1.2 kg or more, and a 3.5-French UAC should be used for infants weighing less than 1.2 kg. Arterial catheters should have a single lumen and be as nonthrombogenic as possible. A 5-French UVC should be used for infants weighing less than 3.5 kg, and an 8-French should be used for infants weighing 3.5 kg or more. A single- or double-lumen UVC can be used; it should not have side holes unless it is being placed specifically for exchange transfusion.

There are many acceptable methods for determining the appropriate depth of UAC and UVC placement; some are based on the shoulder-to-umbilicus length, and others on the infant's birth weight. There are also standardized graphs for determining the appropriate depth of catheter insertion (Fig. 1). To calculate the depth for inserting a high-lying UAC (one that lies above the diaphragm), multiply the infant's weight in kilograms by 3 and add 9 cm, then add the length of the umbilical stump to this value. For positioning a low-lying UAC, multiply the infant's weight in kilograms by 3 and add 9 cm, then add the length of the umbilical

stump to this value and divide by 2. To calculate the appropriate depth for UVC insertion, multiply the infant's weight in kilograms by 3, add 9 cm, then divide by 2 and add 1 cm. Another method involves measuring the length from the tip of the neonate's shoulder to the umbilicus. Calculate 66% of the shoulder-to-umbilicus length to determine the depth of insertion of a UVC. Calculate 110% of the shoulder-to-umbilicus length to determine the depth of insertion for high positioning of a UAC. Low positioning of a UAC, which is also used, is determined by calculating 60% of the shoulder-to-umbilicus length.

The final step in preparation of the catheters includes connecting three-way stopcocks to the ends of both the UAC and the UVC and flushing each catheter with heparinized solution.

PROCEDURE

Confirm the patient's identity. Prepare both the umbilical cord and the abdomen with antiseptic solution (e.g., chlorhexidine or povidone-iodine); clean the entire umbilical stump and cord clamp. Place sterile towels so that just the area around the stump is exposed (Fig. 2). Place an umbilical tie securely around the skin at the base of the umbilical stump. Using straight hemostats, clamp the cord beneath the existing cord clamp. Use an 11-blade scalpel to cut beneath the new clamp approximately 0.5 to 1 cm above the level of the skin, exposing a clean, smooth surface of the cord. If there is any oozing of blood, tighten the umbilical tie. Blot (do not rub) the cord, if oozing continues. Identify the three vessels (Fig. 3). The arteries are smaller and have thicker, muscular walls (Fig. 4). The vein is larger than the arteries and is typically thin-walled and less round than the arteries (Fig. 5).

UAC Placement

Once you have identified the umbilical artery, grasp the cord and Wharton's jelly near the opposite artery and apply traction. Insert the closed tip of a toothless iris forceps 0.5 cm into the opening of the vessel to dilate the opening. Grasp the UAC tip with the iris forceps and insert the catheter through the opening and into the vessel. When the UAC is at the appropriate depth, draw and flush the catheter, and then secure it by suturing through the umbilical stump.¹

UVC Placement

Dilate the opening of the umbilical vein and remove any clot material. Apply traction to the umbilical cord, using a mosquito clamp. Grasp the catheter tip and insert it into the opening of the vein. When you have advanced the catheter to 4 cm, draw back on the syringe to verify blood return. Insert the UVC to the desired depth, and make sure the catheter flushes and draws. Suture the UVC in place, using the same technique as that for suturing the UAC. Leaving the field sterile, confirm placement of the catheter tips with a radiographic examination.²

EMERGENCY UVC PLACEMENT

Certain situations, such as prolonged resuscitation and extreme volume loss, necessitate rapid placement of a UVC to aid in fluid and medication administration. If placement is required immediately after birth, the umbilical vein is the vessel of choice. Prepare the umbilical cord with antiseptic solution; it is often impossible to create a sterile field in an emergency situation. Put on sterile gloves and keep the catheter as sterile as possible; it must be preflushed and attached to a stopcock and syringe. Tie the cord at the base with an umbilical tie and cut the umbilical cord 2 cm above the skin. Then quickly insert the UVC into the umbilical vein to a depth of 3 to 5 cm below the skin (in a term infant), check for blood return at this depth, and secure the catheter between your fingers or with tape. It is imperative that the

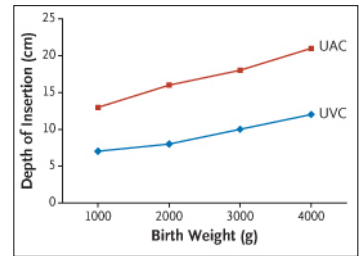


Figure 1. Determining the Appropriate Depth for Catheter Insertion.

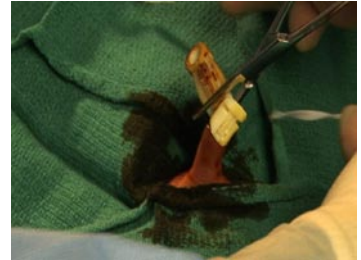


Figure 2. Positioning of Sterile Towel around Umbilical Stump.

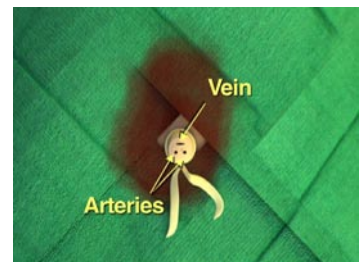


Figure 3. Umbilical Vessels.

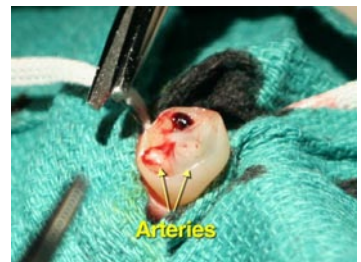


Figure 4. Umbilical Arteries.



Figure 5. Umbilical Vein.

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catheter not be inserted too deeply in order to prevent entry into the hepatic vessels, where medications could potentially cause cellular damage.

COMPLICATIONS

UACs may cause or be associated with thrombosis, embolism, infarction, vasospasm, loss of an extremity, hypertension, paraplegia, congestive heart failure, air embolism, necrotizing enterocolitis, infection, intestinal necrosis or perforation, transection of an omphalocele, Wharton's jelly embolus, and bladder injury. If a catheter is not positioned properly, it can result in vessel perforation, refractory hypoglycemia, peritoneal perforation, false aneurysm, and sciatic-nerve palsy.

Complications associated with UVCs include infection, thromboembolism, perforation of the peritoneum, portal hypertension, digital ischemia, and pneumopericardium. When placed in the wrong position, UVCs can cause pericardial effusion and tamponade, cardiac arrhythmias, thrombotic endocarditis, necrotizing enterocolitis, perforation of the colon, and hepatic necrosis.

Prevention of ischemic and embolic events due to umbilical-vessel catheterization is an area of active research and controversy. Reviews have shown that tip-opening catheters have decreased the number of ischemic and embolic events, as compared with side-opening catheters.^{3,4} Some centers choose to use heparinized fluids in the catheters, although this approach is controversial.⁵