Insertion of Umbilical Arterial and Venous Catheters

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Introduction
The use of umbilical arteries and veins for vascular access was first described in the 1960s and has been an integral part of neonatology since then. This report aims to define the indications, contraindications, methods of insertion and complications of umbilical arterial and venous catheters.

Equipment Required
Sterile prepackaged UAC and UVC sets are available in most units and contain most equipment required. This includes: dressing drapes, measuring tape, forceps, scalpel, dilator, suture scissors, three-way taps, syringes, needles. In addition, umbilical cord tape, suture material and antiseptic solution. Heparinised solution is needed for UAC flush. Full sterile scrub and gown are necessary.

Single and double lumen UACs and UVCs are available. Size 3.5 French UAC is recommended for infants weighing <1.2 kilogrammes and 5 French for infants more than this. Size 5 French UVC is recommended for infants weighing less than 3.5 kgs and 8 French for infants over 3.5 kgs.

Methods
Method of Insertion

- Measure the distance required for correct placement.
- Full sterile precautions are important throughout.
- The legs and buttocks should be monitored repeatedly for evidence of vascular compromise.
- Flush the UAC and UVC with heparinised solution and attach three-way taps and syringes.
- Cleanse the anterior abdominal wall and umbilical cord stump with antiseptic solution. Tie the base of the umbilical cord to prevent excessive venous bleeding.
- Cut the cord 1 cm above the abdominal wall. A long umbilical stump is more difficult to cannulate. A short stump allows less margin of error.
- Grasp the umbilical stump using toothed forceps. Contact should not be made between the vessels and the forceps or your hand and the cord.
- Identify both arteries and the vein. The vein is thinner-walled with a larger lumen than the arteries. The vein generally lies superiorly. The arteries have firmer, thicker walls which protrude above the top of the umbilical stump. The arteries are often inferior to the vein but their paths spiral around it.
- Dilate the orifice of one of the arteries with a forceps or artery dilator. Insert the UAC. Advance slowly to the required distance. Significant resistance should not be encountered. Aspirate the UAC. Arterial blood should flow back easily.
- The UVC is then passed by a similar technique through the vein to the predefined distance. If there is any doubt whether the umbilical artery or vein has been cannulated, a blood sample may be taken and blood gas analysis performed on it.
- The catheters are then secured by suturing into position and goal-post method of taping.
- Confirm catheter position by x-ray. The correct UVC position is 0.5-1.0 cm above the diaphragm. Low-lying UVCs are acceptable in emergency situations. The correct UAC positions are between T6-T9 for a high UAC (above the origin of the Celiac Axis) and between L3-L4 for a low UAC (below the origin of the renal and mesenteric vessels). Note that on x-ray, the UAC curls inferiorly then turns superiorly as it passes through the internal iliac artery.
- After contaminating the sterile field, neither catheter should be advanced further but either can be withdrawn if required.

Distance
Several diagrams and charts for distance of insertion of UAC and UVC exist. Most of this data is based on the work of Dunn et al 1966[1].
Two slightly less precise formulae are commonly used:
UAC length = distance from shoulder tip to umbilical cord
+ length of stump
UVC length = distance from xiphisternum to umbilical cord
+ length of stump

Complications

1. Sepsis may occur at the time of catheter placement or during use. Strict aseptic technique at all times reduces this risk.
2. Vascular compromise can occur with use of UACs. This manifests as pallor, cyanosis, poor perfusion of the legs or buttocks or weak or absent femoral pulses. Removal of the arterial line is necessary in this case.
3. Hypertension is a long-term complication of central arterial access.
4. Vessel perforation may occur at the time of catheter insertion and requires surgical intervention.
5. Haemorrhage may occur if the base of the cord is not tied during insertion or if tubing becomes disconnected during catheter use.

Table 1: Indications and Contraindications for Insertion of UAC

UAC Insertion	
Indications	***Contraindications***
Primary	Vascular access of lower extremities
Frequent monitoring of PaO2 or oxygenation	Necrotising enterocolitis
Angiography	Peritonitis
Resuscitation (UVC is first choice)	Omphalitis
	Omphalocoele
Secondary	Gastroschisis
Fluid or medication administration	
Exchange transfusion	
Frequent blood sampling in VLBW* infants	

* Very Low Birth Weight (i.e. less than 2000 grams)

Table 2: Indications and Contraindications for Insertion of UVC

UVC Insertion	
Indications	***Contraindications***
Primary	Necrotising Enterocolitis
Emergency vascular access for fluid and medication administration	Peritonitis, Omphalitis, Omphalocoele
Secondary	Gastroschisis
Exchange transfusion	
Long term access in LBW* infants	
Diagnosis of TAPVD below the diaphragm	

* Low Birth Weight (i.e. less than 2500 grams)
 Total Anomalous Pulmonary Venous Drainage

6. Thrombosis at the catheter tip or embolus of air, clot or catheter tip may occur at any stage. Emboli may pass into either the pulmonary or systemic circulations. Use of heparinised flush helps reduce this risk.

7. Necrotising enterocolitis, hepatic necrosis or portal hypertension may occur if a UVC is placed in the liver or in the portal system.

8. Cardiac arrhythmias may occur if a catheter is placed close to the heart causing irritation. Pericardial effusion, cardiac tamponade, endocarditis and hydrothorax may all occur.

Special Considerations

- High UACs are associated with fewer complications than low UACs. There is no evidence to support the use of low-lying UACs. High arterial catheters are now recommended exclusively.[2]

- Heparinisation of the fluid infused through a UAC decreases the likelihood of occlusion of the UAC without increasing the incidence of intraventricular haemorrhage.[3] However, the confidence intervals for these effects in this meta-analysis are wide.

- Catheters with an end hole should be used in preference to catheters with a side hole. End hole catheters have a lower incidence of aortic thrombosis.[4]

- There have been no proven benefits or disadvantages of any one type of catheter material over other types. Therefore, choice of catheter material may be dicatated by price, availability and selection.[5]

- Prolonging the time taken to sample blood (40 seconds vs 20 seconds) from an umbilical arterial catheter, protects against significant decreases in cerebral oxygenated haemoglobin and tissue oxygenation index. This may contribute to cerebral protection in vulnerable neonates.[6]

- Care should be exercised when using antiseptic as prolonged skin contact with it has been associated with severe burns.

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