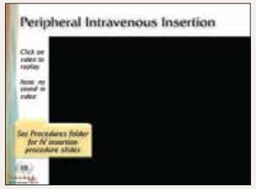
When a video appears in the program, there will be a note regarding whether sound is present on the video or not. If there is sound, then you will need to connect your computer to speakers.

Speakers will also be required for other sound clips (grunting and stridor) that are incorporated into slides in the Airway module.

NICU



Non NICU

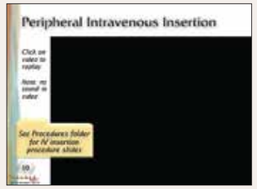


Figure 1.3. Setting up for and securing a peripheral IV.

Insertion of a Peripheral IV

For most infants, appropriate sizes are:
24 gauge IV catheter or 23 or 25 gauge butterfly needle (with ¾ inch needle length).

⚠ To reduce the risk of a needle stick injury and exposure to bloodborne pathogens, use a needle or catheter system with a safety device. When finished with the procedure, promptly and properly dispose the shielded stylet or needles in a regulation sharps container and wash hands or apply an antibacterial cleansing solution to hands.

Preparation for Insertion of a Peripheral IV

- Wash and dry hands or apply an antiseptic solution to hands before beginning.
- Assemble all of the equipment that will be necessary for the procedure.
- Prepare the tape and clear surgical dressing so that it is ready to use when the IV is inserted.
- Apply gloves.
- Clean the skin with antiseptic solution around the insertion site and allow the solution to dry.
- Optional: a non-latex material tourniquet may be placed on the extremity above the area where you will insert the needle (take care to not cut off the blood supply).

⚠ Observe evidence-based guidelines for hand hygiene before and after patient contact![38]

Step 1

A (cold light) transillumination light or a bright pen light held beneath the hand or foot helps the veins become visible. Insert the needle or catheter into the vein and ensure there is good blood return. Hypotensive infants may have very slow blood return, so be patient. Remove the tourniquet (if one was used) when blood return is noted. If using a catheter, follow the manufacturer's recommendation for advancing the catheter and for discarding or securing the needle stylet.

⚠ Take care to check that any light source used does not transmit heat, which could burn the skin.

Step 2

If using a catheter, secure it by placing a small piece of sterile transparent semipermeable membrane dressing over the catheter from the hub down to below the insertion site. If this dressing is not available, then secure the hub with a piece of ½ inch tape. Avoid covering the needle insertion site with tape as this will obscure observation of the site for infiltration or redness. If using a butterfly needle, place the tape such that it also covers the butterfly wings.

Step 3

While taping, periodically ensure patency by flushing the IV with a small amount of sterile normal saline (NS).

NICU

Non NICU

Step 4

Place a ½ inch piece of tape over the hub. Avoid placing tape over the insertion site of the needle or catheter so that the site can be monitored during infusion of fluids or medications. The sterile transparent semipermeable membrane dressing will allow for optimal observation, yet hold the needle/catheter securely.

Step 5

At times it may be necessary to use a padded “board” to prevent flexion of the arm or leg. Try to secure the area in the most anatomically correct position. To help prevent accidental dislodgment of the IV, secure the tubing with a ½ inch piece of tape such that the tape does not touch the hub or wings of the IV needle. Double back tape or cushion the tape with a gauze pad to prevent unnecessary contact with the skin.

Monitoring

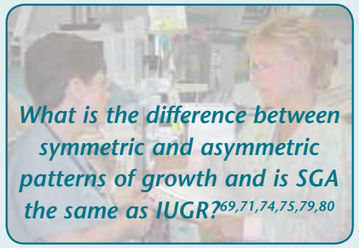
Observe the IV site closely for swelling or redness which may indicate infiltration. If these signs are observed then it is safest to remove the IV and insert a new one in another area. Document hourly the appearance of the IV and the amount of fluid that was infused in the past hour. Protect the IV from dislodgment whenever the infant is moved.

Inadequate Glycogen Stores and Decreased Glucose Production: *High Risk Groups*

(continued)

A chronically stressed fetus may use most, if not all, of the placentally transferred glucose for growth and survival. This limits the ability to make or store glycogen for use after birth. The risk for hypoglycemia in term infants who have intrauterine growth restriction (IUGR) is estimated at 25 percent. Preterm infants with IUGR are at even higher risk.[78]

Clinical Tip



What is the difference between symmetric and asymmetric patterns of growth and is SGA the same as IUGR?[69,71,74,75,79,80]

Symmetric growth restriction (or symmetric SGA) infants have a lower weight, length, and head circumference for their gestational age. When these parameters are plotted on a graph, each will usually be at or below the 10th percentile. Symmetric SGA growth often results from intrauterine viral infection in early gestation, longstanding maternal disease with placental growth restriction present throughout most of pregnancy, or from chromosomal or genetic causes.

Intrauterine growth restriction (IUGR) is a term used to describe infants who have altered fetal growth, especially in the third trimester when lipid accumulation is greatest and growth is rapid. However, IUGR can at times be detected on a second trimester ultrasound.

The term "IUGR" is often used interchangeably with "SGA", however, they are not the same thing. Infants with IUGR have **asymmetric growth restriction**. Their weight will be low for their gestational age, followed by some impact on length, but with relatively less restriction in brain growth and head circumference (often referred to as "head sparing"). IUGR infants may appear "wasted," long and thin. This asymmetric pattern of growth usually results from maternal medical conditions or poor placental function that disrupts oxygen and nutrient delivery to the fetus during the last trimester of pregnancy. While the cause of growth restriction may not be easily apparent, assessment of the above factors (genetics, infection, maternal medical conditions, and placental function) must be considered as they may impact future pregnancies.

It is important to perform an accurate gestational age assessment before plotting the weight, head circumference, and length on the growth chart. If the gestational age assessment is incorrect, then the assessment of the infant's size may be inaccurate. See Appendices 1.2 and 1.3 for female and male growth charts.[81]

Stress the importance of close/frequent glucose monitoring in the sick neonate. However, it is important that you also discuss using good judgment when deciding how often to monitor the blood sugar. If the trend is towards a normal blood sugar, then less frequent monitoring is indicated.

Dextrose-containing solutions should be treated like any other medication; a "dose in milligrams" is given when the IV fluid is administered.

For more advanced students
It is helpful to understand the concept of "glucose infusion rate" (GIR) and how to calculate GIR.

$D_{10}W$ contains 10 grams of glucose per 100 mL of IV solution. This equates to 100 mg of glucose per milliliter.

- A bolus of 2 mL/kg of $D_{10}W$ equals a dose of 200 mg per kg of glucose.
- Practice calculating the glucose infusion rate by using this formula:
  Glucose (mg/kg/min) = (% dextrose in solution x IV rate in mL/hour x 0.167) divided by weight in kg.

Practice Examples

1) 3.5 kg infant is receiving $D_{10}W$ at a rate of 80 mL/kg/day, equals 11.7 mL/hr. The GIR calculation is as follows:

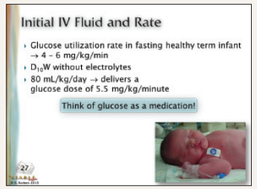
- (10 x 11.7 x 0.167) divided by 3.5 = glucose infusion rate in mg/kg/minute
- 19.539 divided by 3.5 = 5.58 mg/kg/minute

2) 3.5 kg infant is receiving $D_{12.5}W$ at a rate of 80 mL/kg/day, 11.7 ml/hour.

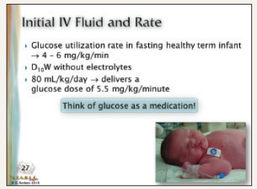
- (12.5 x 11.7 x 0.167) divided by 3.5 = glucose infusion rate in mg/kg/minute
- 24.42 divided by 3.5 = 6.98 mg/kg/minute

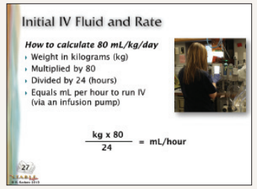
Alter the infant's weight and dextrose concentration if more practice is desired.

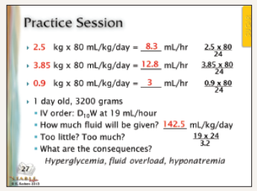
NICU

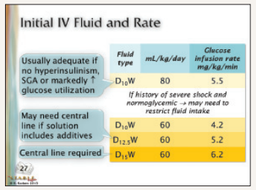


Non NICU









For Non-NICU students
Students will need a calculator to participate in the Practice Session on how to calculate the IV infusion rate.

In addition to learning how to calculate the hourly IV infusion rate, students should also know how to calculate how much total fluid (mL/kg/day) would be administered when an order is written for an hourly infusion rate. In the example, the physician order for 19 mL per hour would provide too much fluid for a one-day old infant. Discuss the potential consequences of administering too much fluid (includes: hyperglycemia, fluid overload, and hyponatremia).

Initial IV Fluid and Rate

Establish intravenous (IV) access and administer a 10% dextrose solution ($D_{10}W$), without electrolytes, at a rate of 80 mL per kilogram per day (80 mL/kg/day). This provides a glucose infusion rate of 5.5 mg/kg/minute, which is similar to the liver glucose production rate in healthy term newborns — 4 to 6 mg/kg/minute.[32,57,97]

Figure 1.6. Initial IV fluid management for the sick infant.

$D_{10}W$ without electrolytes*

80 mL per kilogram per 24 hours (80 mL/kg/day)

Infuse via an infusion pump

**If the infant is older than 24 hours, it may be necessary to add electrolytes to the IV solution.*[114]

In the absence of conditions related to hyperinsulinemia, for infants with limited or no glycogen stores (for example, preterm and small for gestational age infants), or those without significantly increased glucose utilization, a glucose infusion rate of 5.5 mg/kg/minute (80 mL/kg/day of $D_{10}W$), should adequately maintain the blood sugar above 50 mg/dL (2.8 mmol/L). Figures 1.6 and 1.7 summarize the initial IV fluid to provide for sick infants and how to calculate the hourly infusion rate. Table 1.3 shows the glucose infusion rate that is provided with varying fluid infusion rates and varying dextrose concentrations. Treatment of a blood glucose less than 50 mg/dL (2.8 mmol/L) is outlined in Table 1.4.

Dextrose concentration	Infusion volume mL/kg per 24 hours (mL/kg/day)	Glucose infusion rate mg/kg delivered per minute (mg/kg/min)
$D_{10}W$	60	4.2
$D_{10}W$	80 (usual starting rate)	5.5 (usual starting dose)
$D_{10}W$	100	6.9
$D_{12.5}W$	60	5.2
$D_{12.5}W$	80	6.9
$D_{12.5}W$	100	8.7
$D_{15}W$	60	6.3
$D_{15}W$	80	8.3
$D_{15}W$	100	10.4

Table 1.3. Effect of varying dextrose concentrations and infusion rates on the rate of glucose that is delivered in mg/kg/minute.

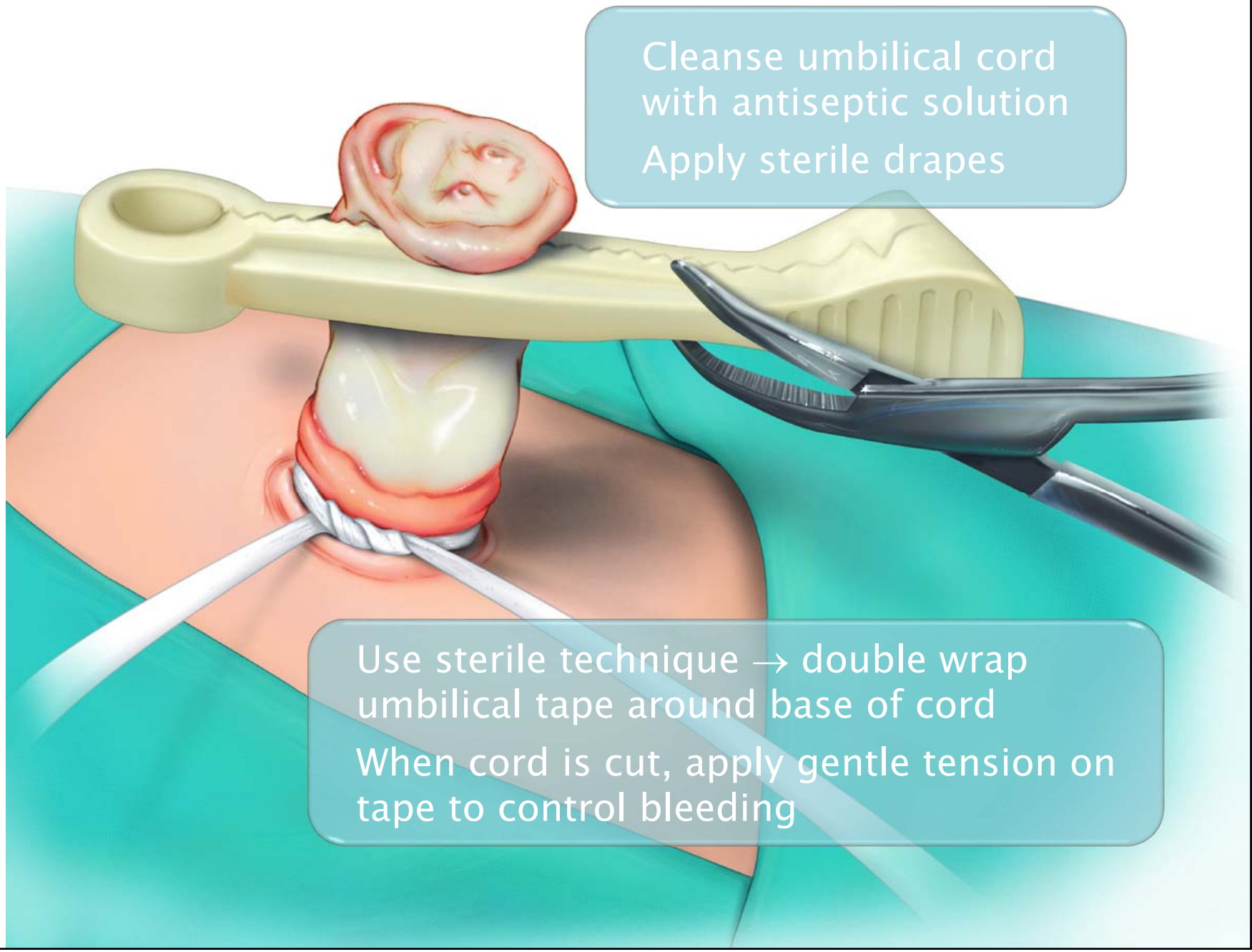
Umbilical Vein Catheter (UVC) Insertion Procedure

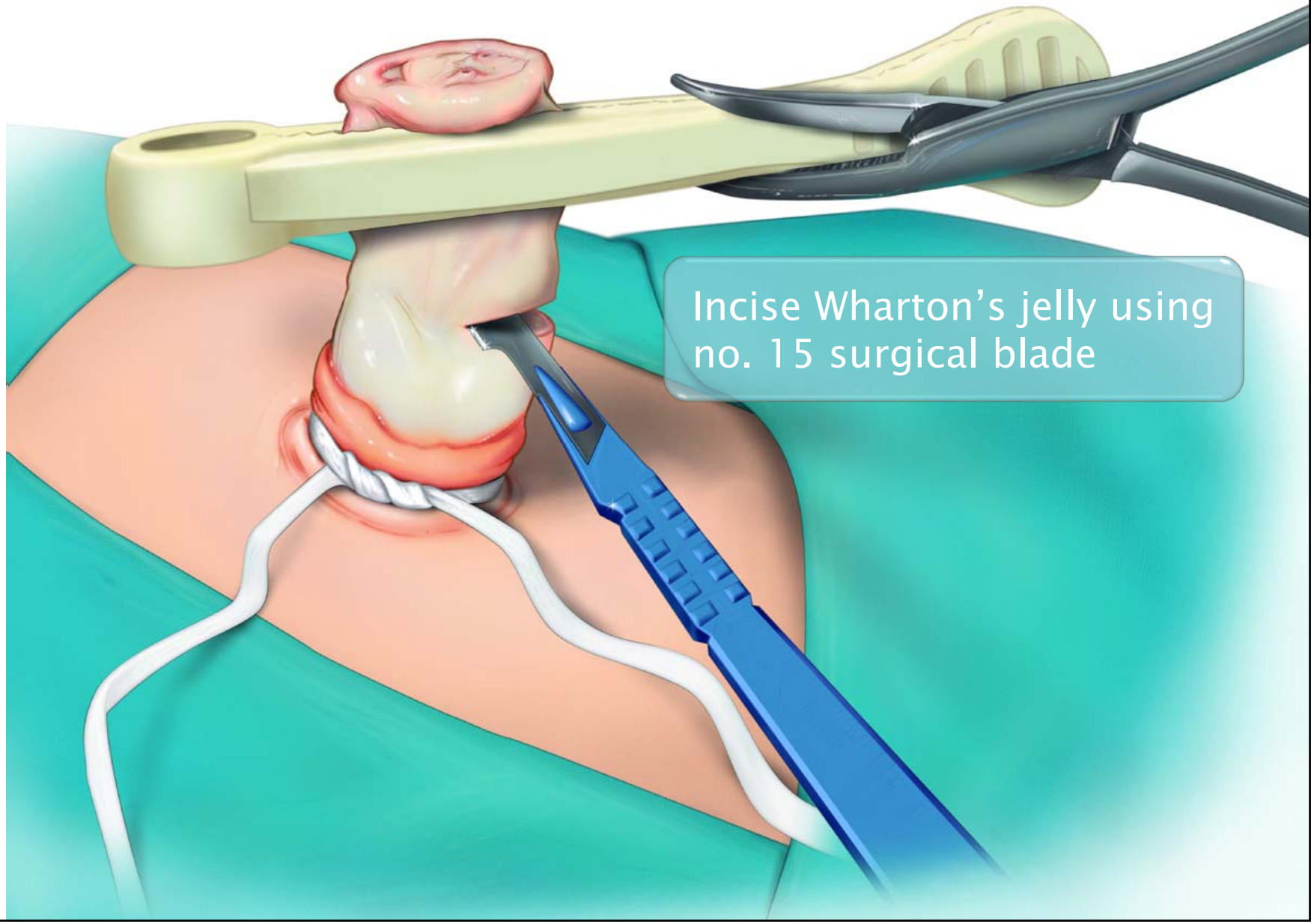
- Use sterile technique → equipment, gown, gloves, hat, mask, drapes
- Determine depth of insertion prior to starting
- Confirm placement with x-ray and repeat x-ray if the line is repositioned

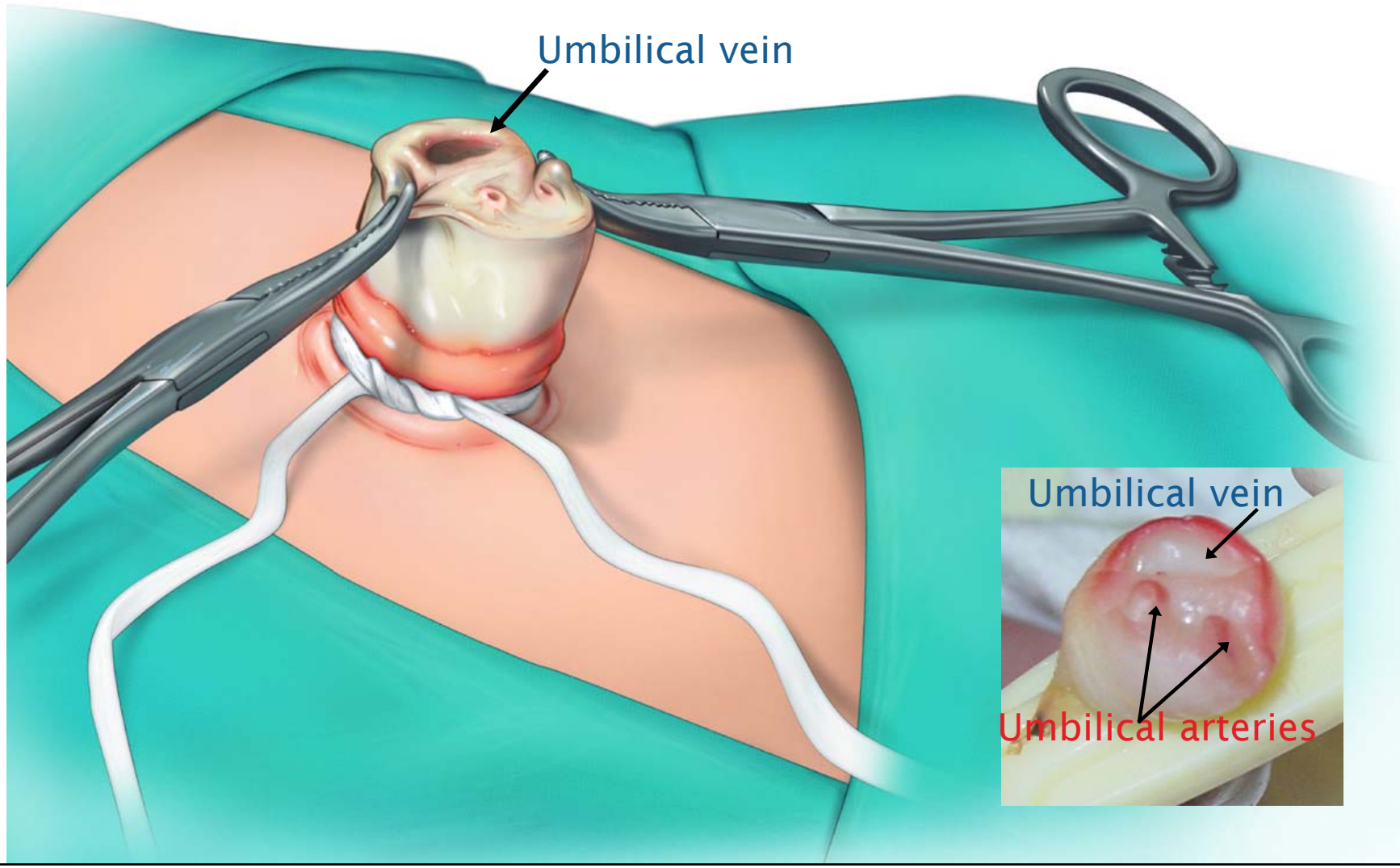
Catheter Size

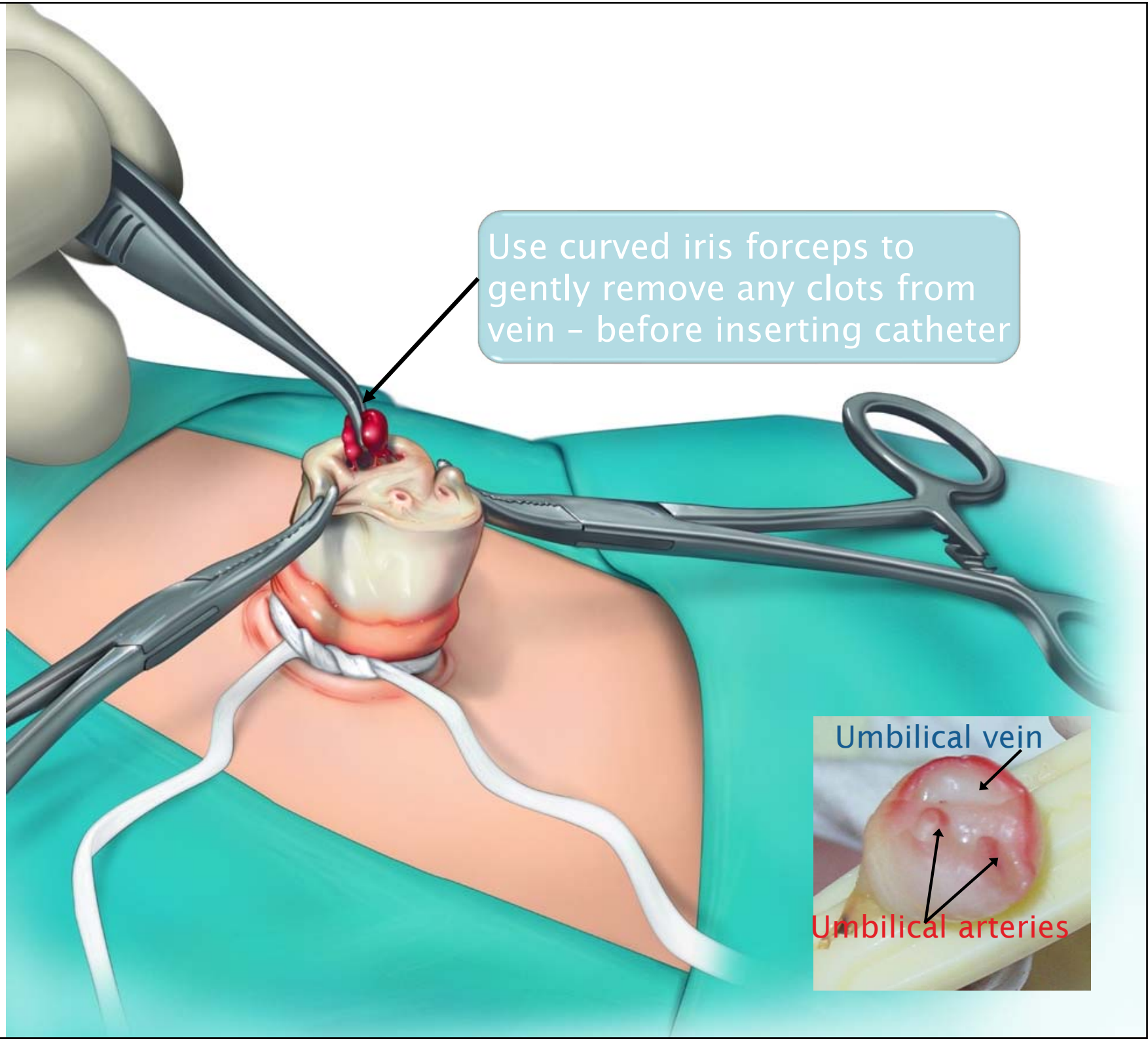
- Under 1.5 kg → 3.5 French
- Over 1.5 kg → 5 French

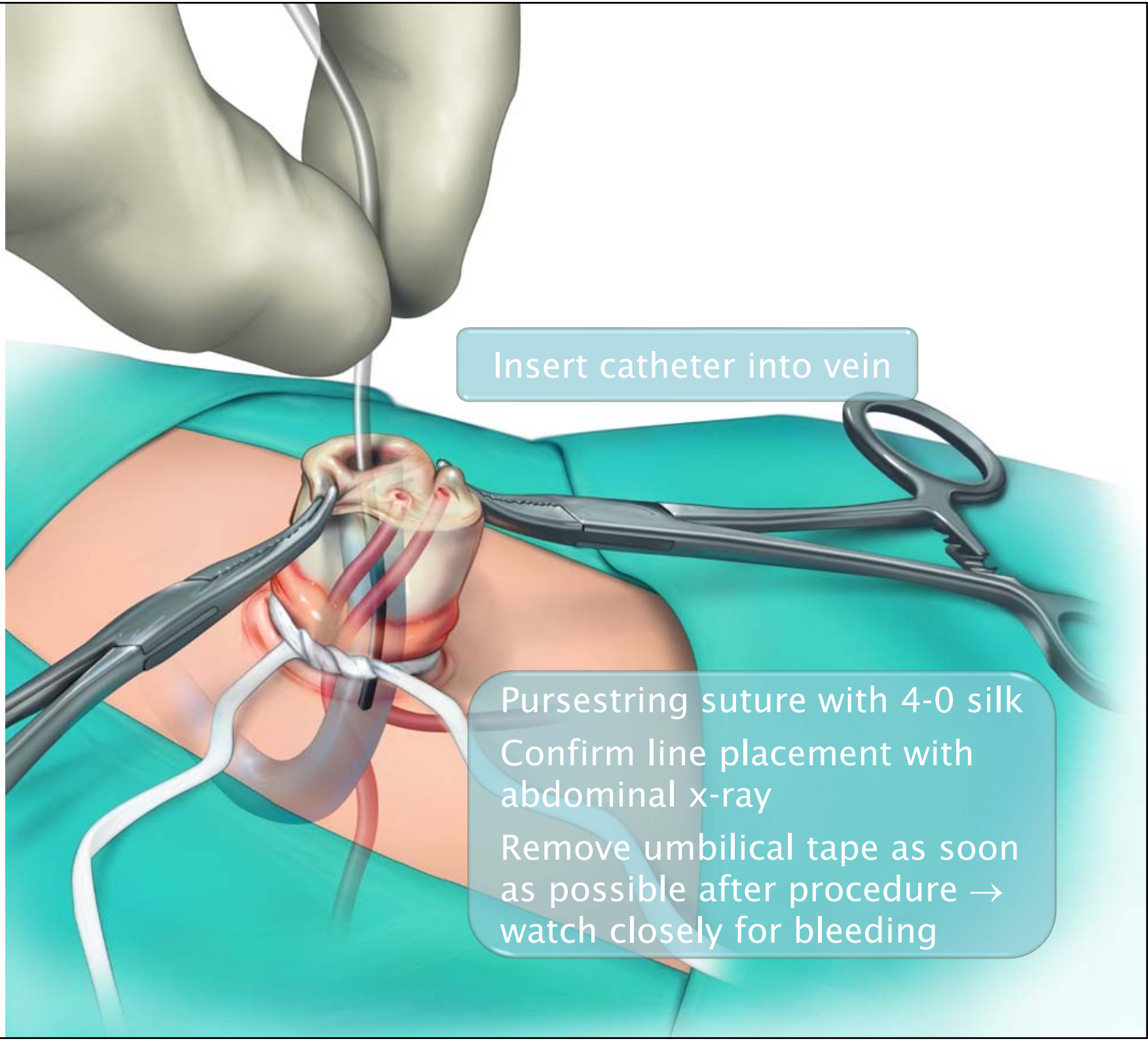
Umbilical Vein Catheter (UVC) Insertion Procedure




Incise Wharton's jelly using
no. 15 surgical blade

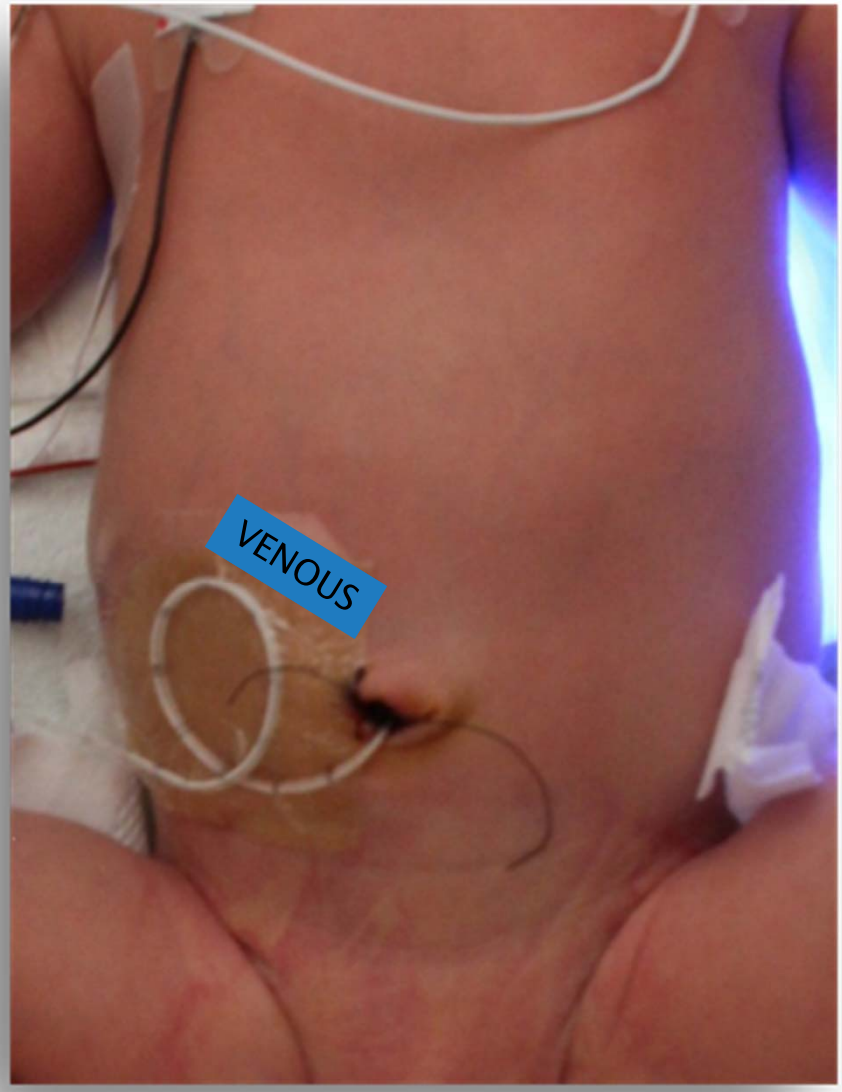

Umbilical vein
Umbilical vein
Umbilical arteries


Use curved iris forceps to gently remove any clots from vein – before inserting catheter
Umbilical vein
Umbilical arteries


Insert catheter into vein
Pursestring suture with 4-0 silk
Confirm line placement with abdominal x-ray
Remove umbilical tape as soon as possible after procedure → watch closely for bleeding

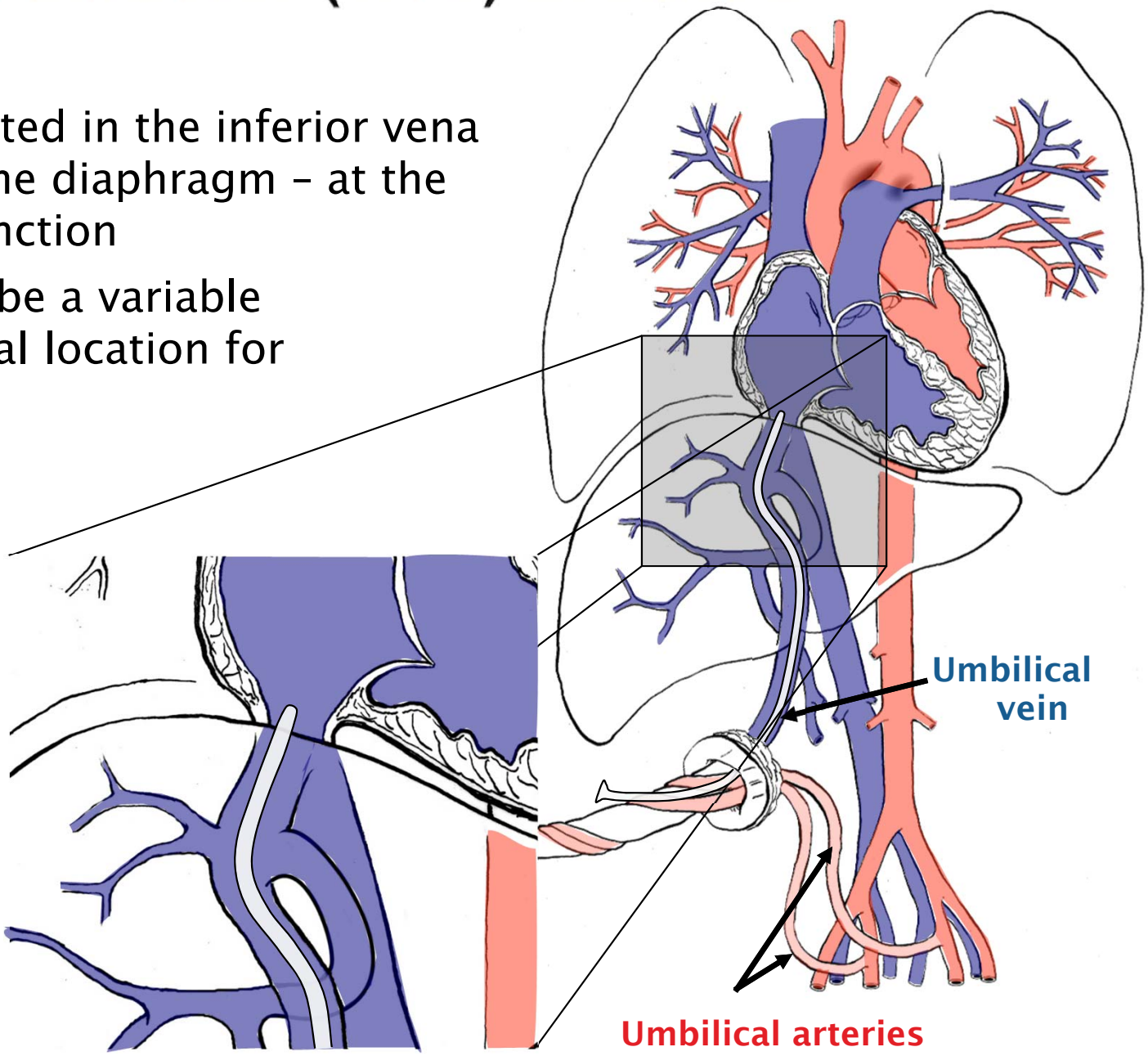
Umbilical Vein Catheter (UVC) Insertion Procedure

- After placement, use sterile water to remove antiseptic solution before applying the dressing
- Use hydrocolloid base layer to protect skin
- Apply transparent surgical dressing to secure the catheter
- Label central lines (venous or arterial) to clearly identify the type of line in place

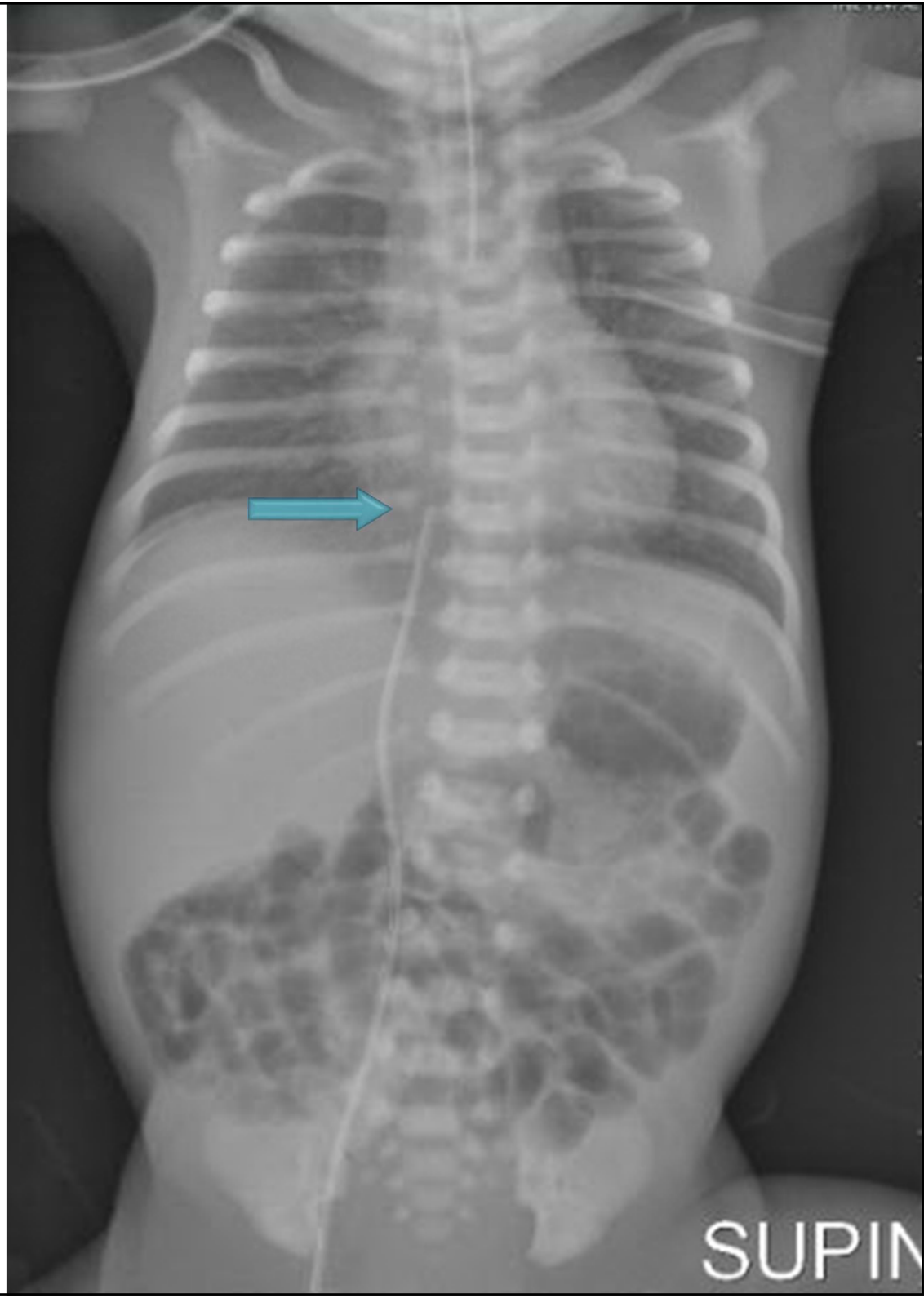


Umbilical Vein Catheter (UVC) Location

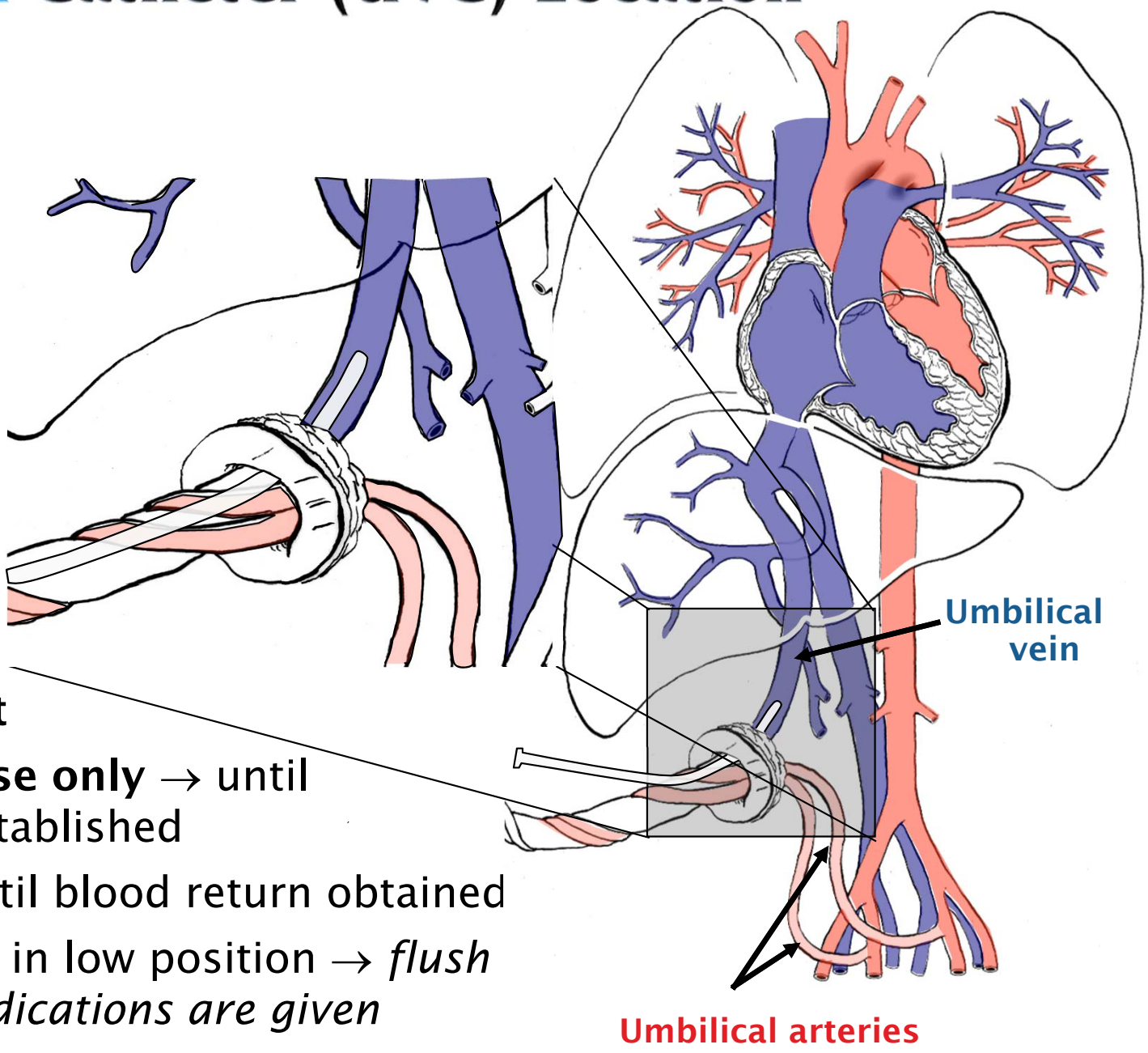
- Tip should be located in the inferior vena cava (IVC) above the diaphragm – at the right atrial (RA) junction
  - Note: there will be a variable thoracic vertebral location for each baby



UVC tip in optimal position at inferior vena cava/right atrial junction



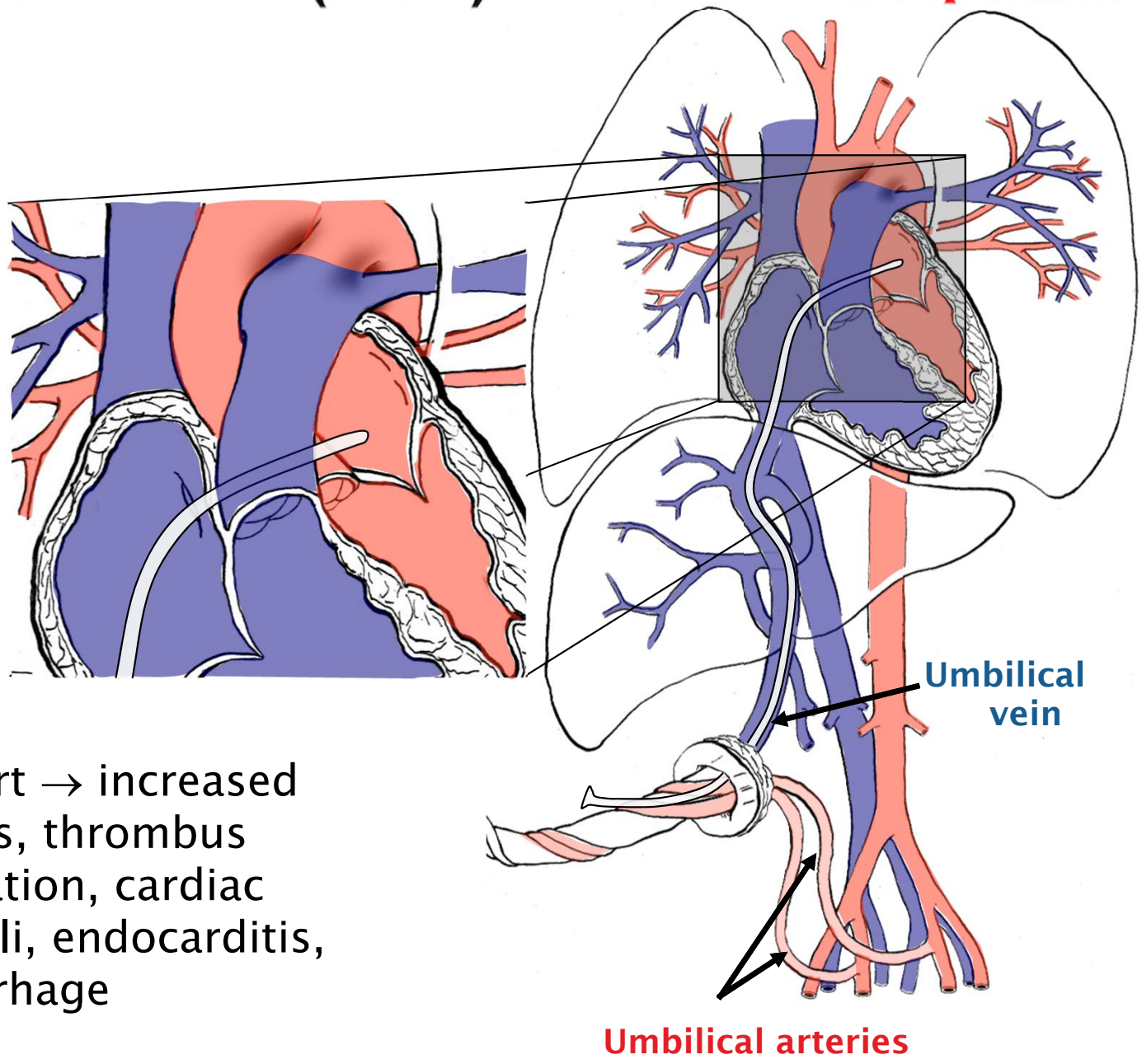
Umbilical Vein Catheter (UVC) Location



Low UVC Placement

- **For emergency use only** → until other IV access established
- Insert 2 – 4 cm until blood return obtained
- Non-pulsatile flow in low position → *flush catheter after medications are given*

Umbilical Vein Catheter (UVC) Location - Malposition

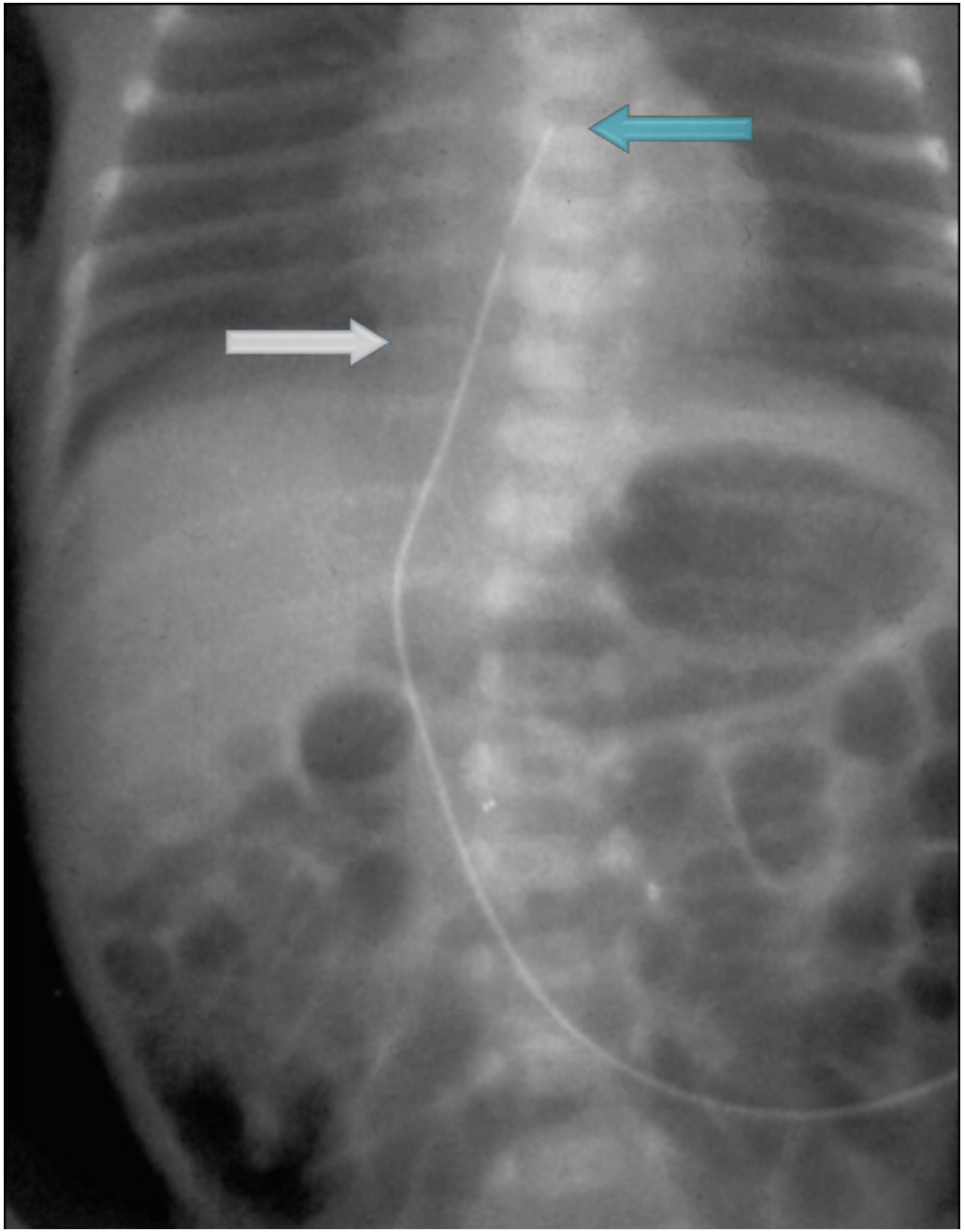


⚠ Tip located in heart → increased risk of arrhythmias, thrombus formation, perforation, cardiac tamponade, emboli, endocarditis, pulmonary hemorrhage

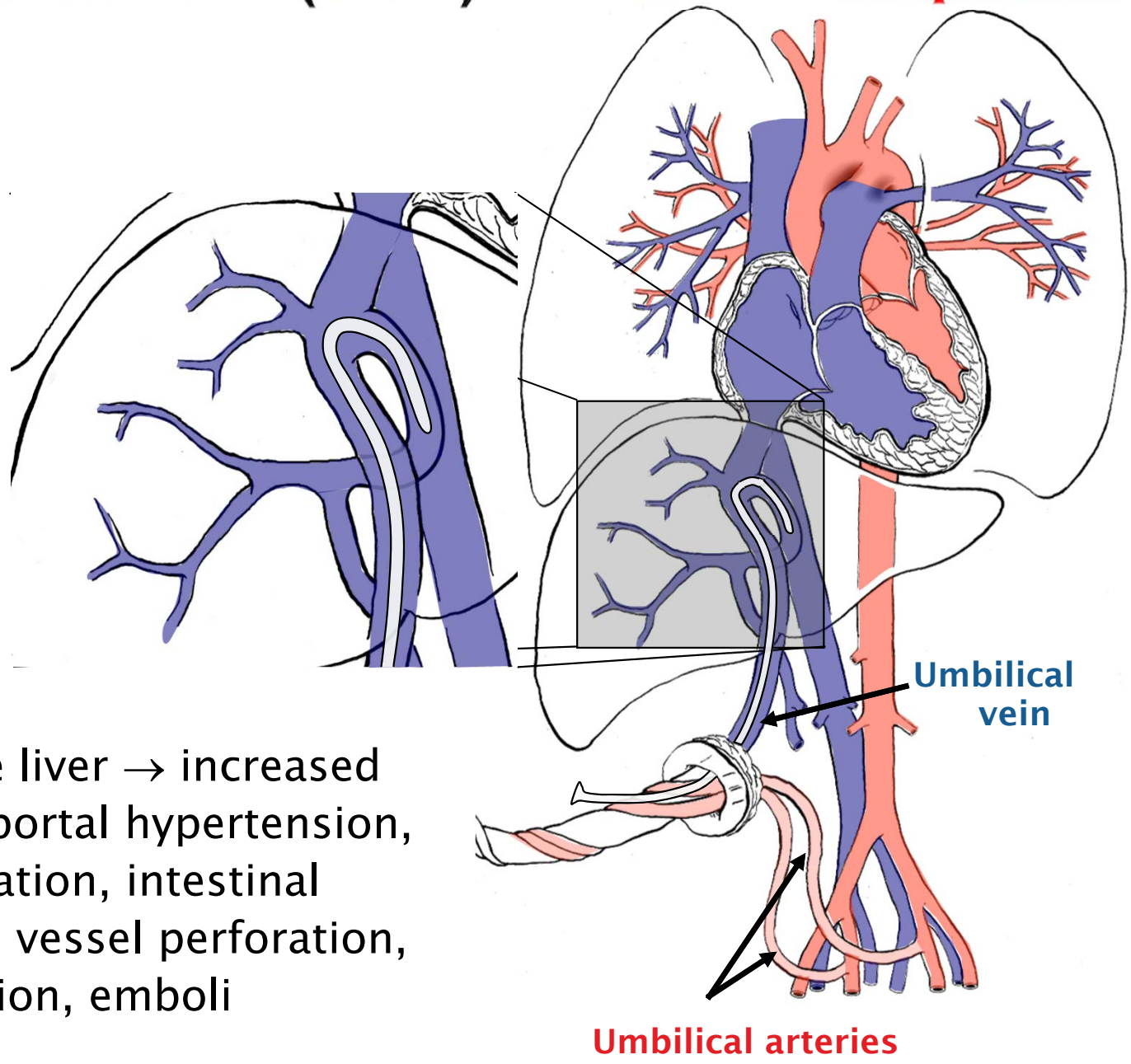
Umbilical Vein Catheter (UVC) Location - Malposition

UVC tip too deep – across foramen ovale in left atrium or pulmonary vein

Pull back to here (IVC/RA junction)



Umbilical Vein Catheter (UVC) Location - Malposition



⚠ Tip located in the liver → increased risk of necrosis, portal hypertension, peritoneal perforation, intestinal ischemia, hepatic vessel perforation, thrombus formation, emboli

Umbilical Vein Catheter (UVC) Location - Malposition

UVC tip malpositioned in the portal venous system and should be removed

Umbilical Vein Catheter (UVC) Location - Malposition

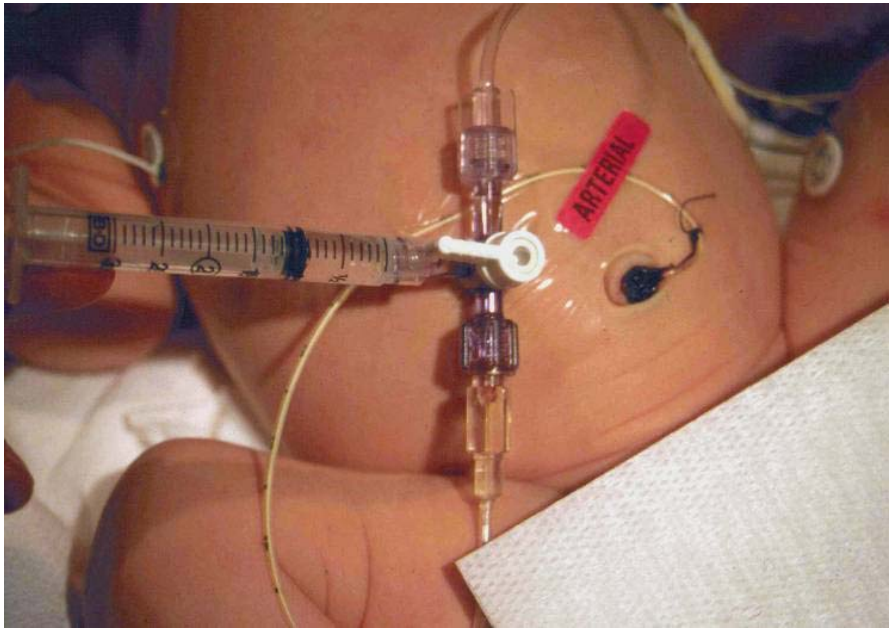
UVC tip malpositioned in the liver and should be removed

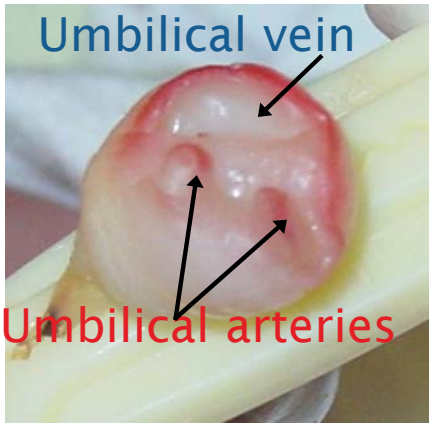
Umbilical Artery Catheter (UAC) Procedure

- Use sterile technique → equipment, gown, gloves, hat, mask, drapes

Catheter Size

- Under 1.5 kg → 3.5 French
- Over 1.5 kg → 5 French





Umbilical Artery Catheter (UAC) Procedure

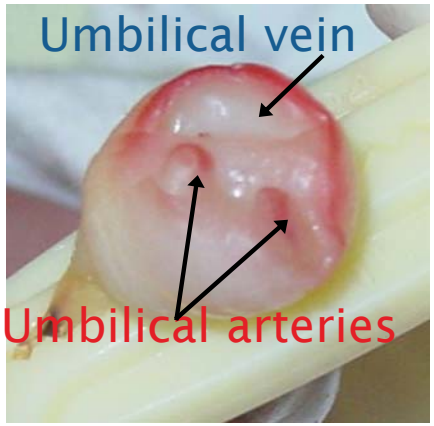
Location

- **High line** → tip located between T6 and T9 *(preferred location)*
- **Low line** → tip located between L3 and L4
- Determine depth of insertion before starting procedure

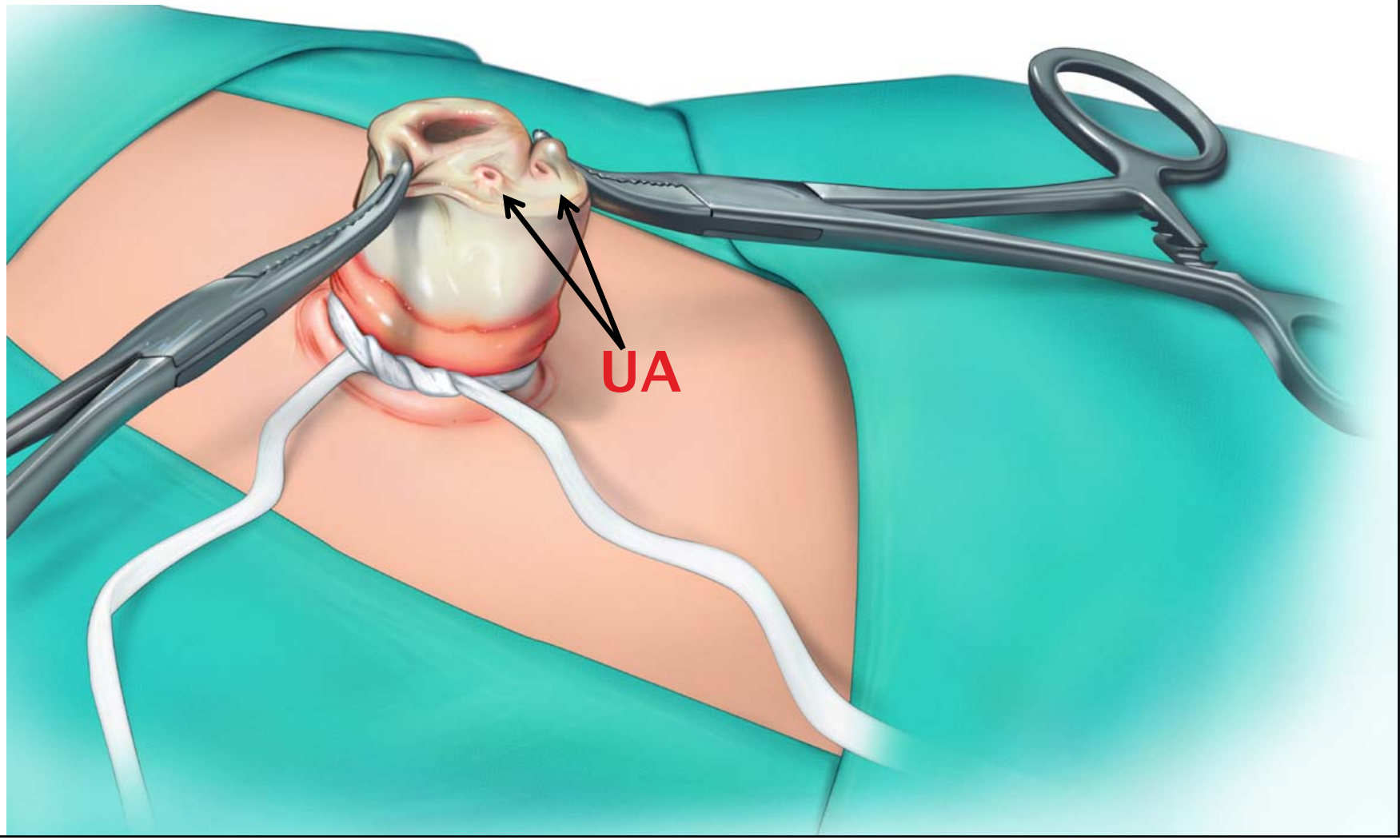
High UAC location calculation

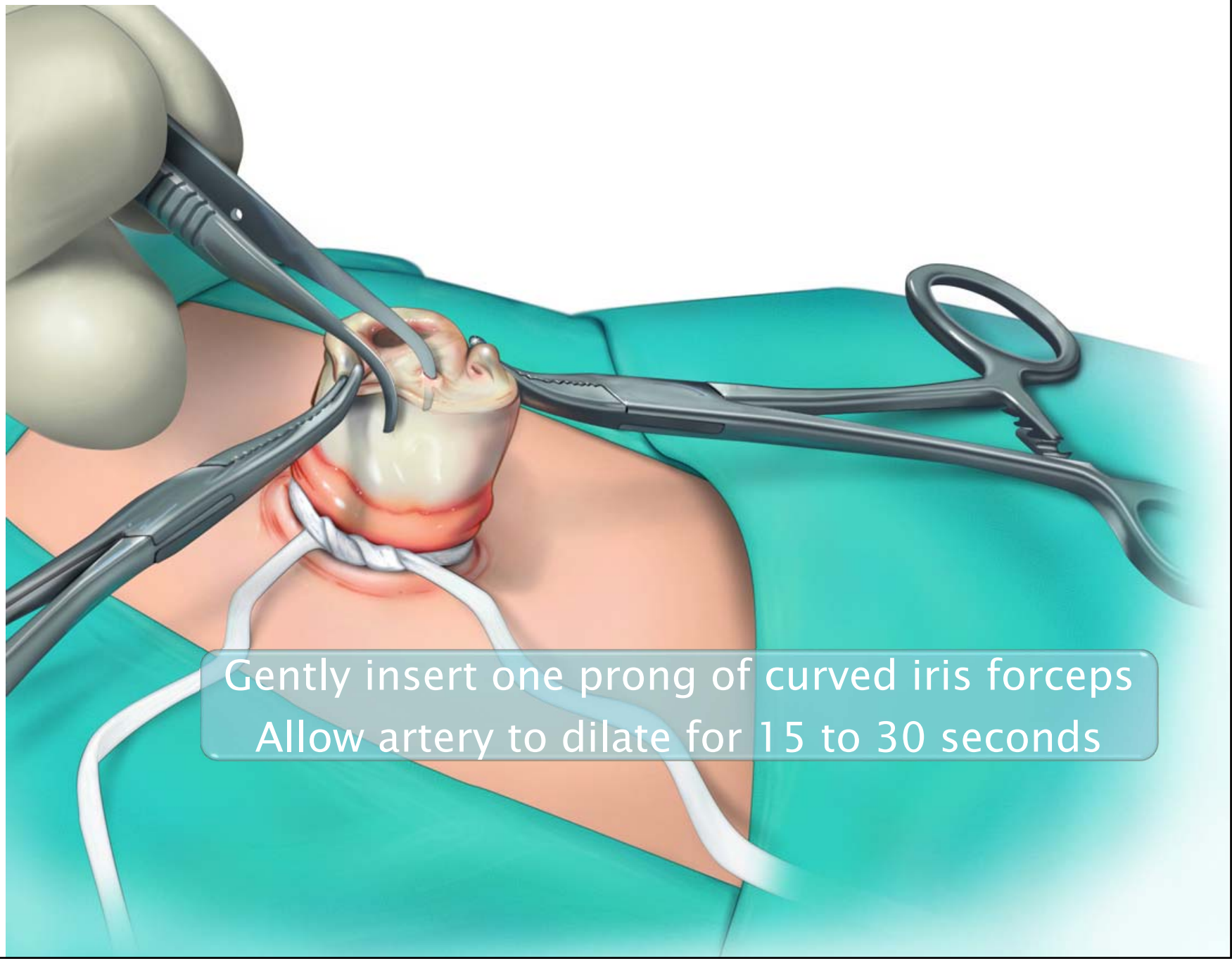
- To calculate the umbilical artery catheter insertion length (at the level of the umbilical cord), in centimeters
  = **[3 X birth weight (in kg)] + 9**
- Confirm placement with x-ray and repeat the x-ray if the line is repositioned

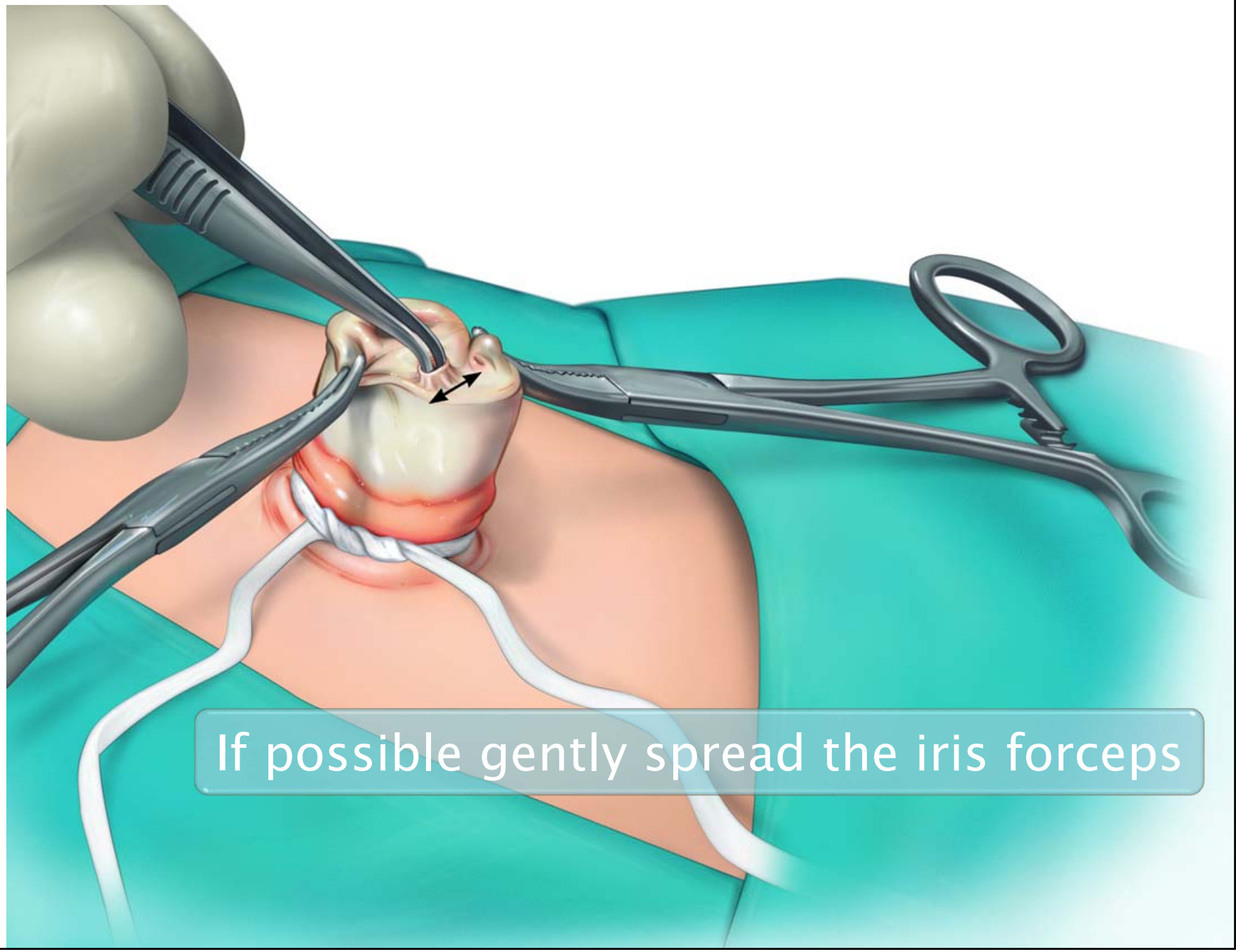
Note: UVC insertion depth calculation:
[0.5 X high line UA catheter length (in cm)] + 1

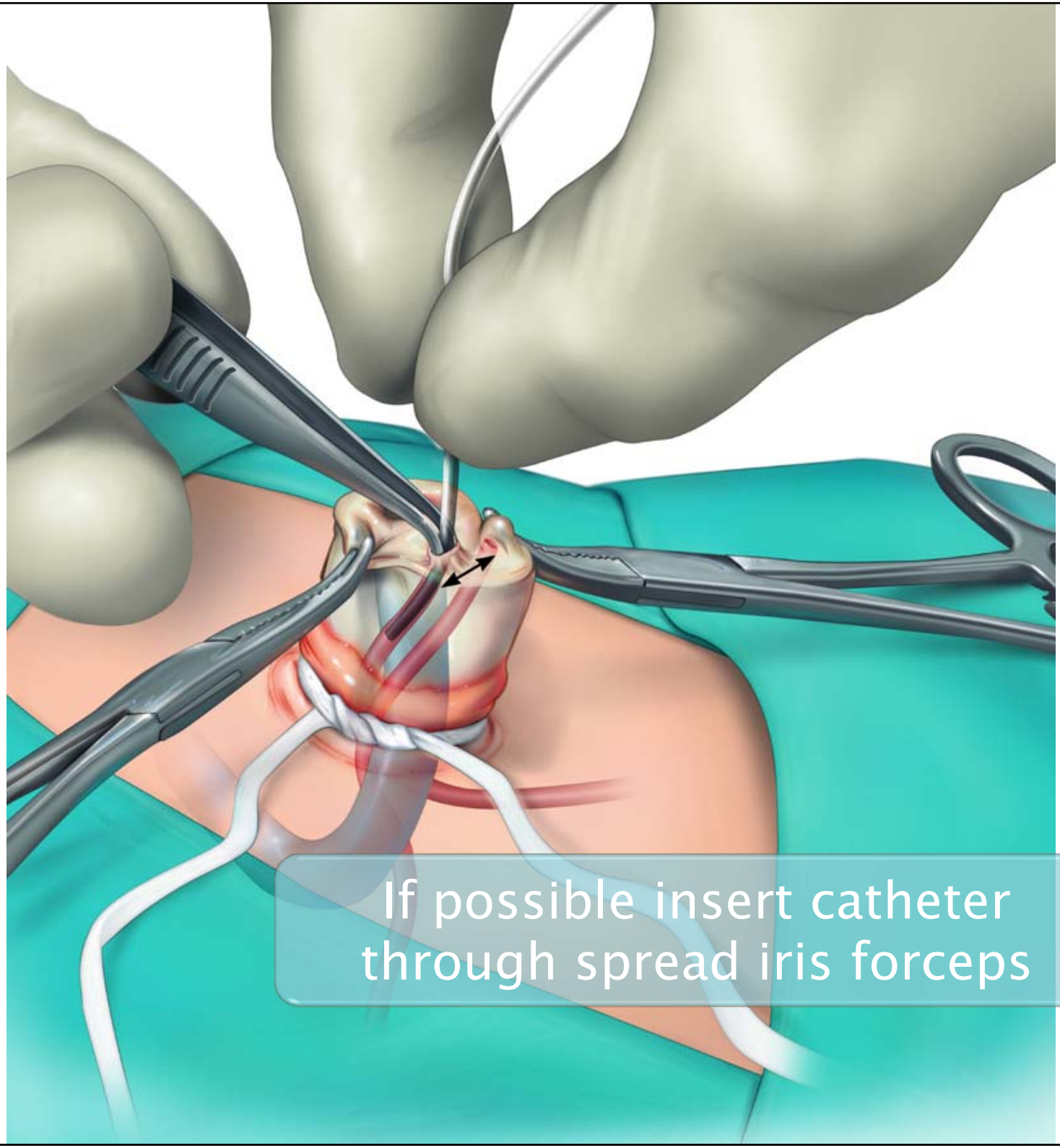


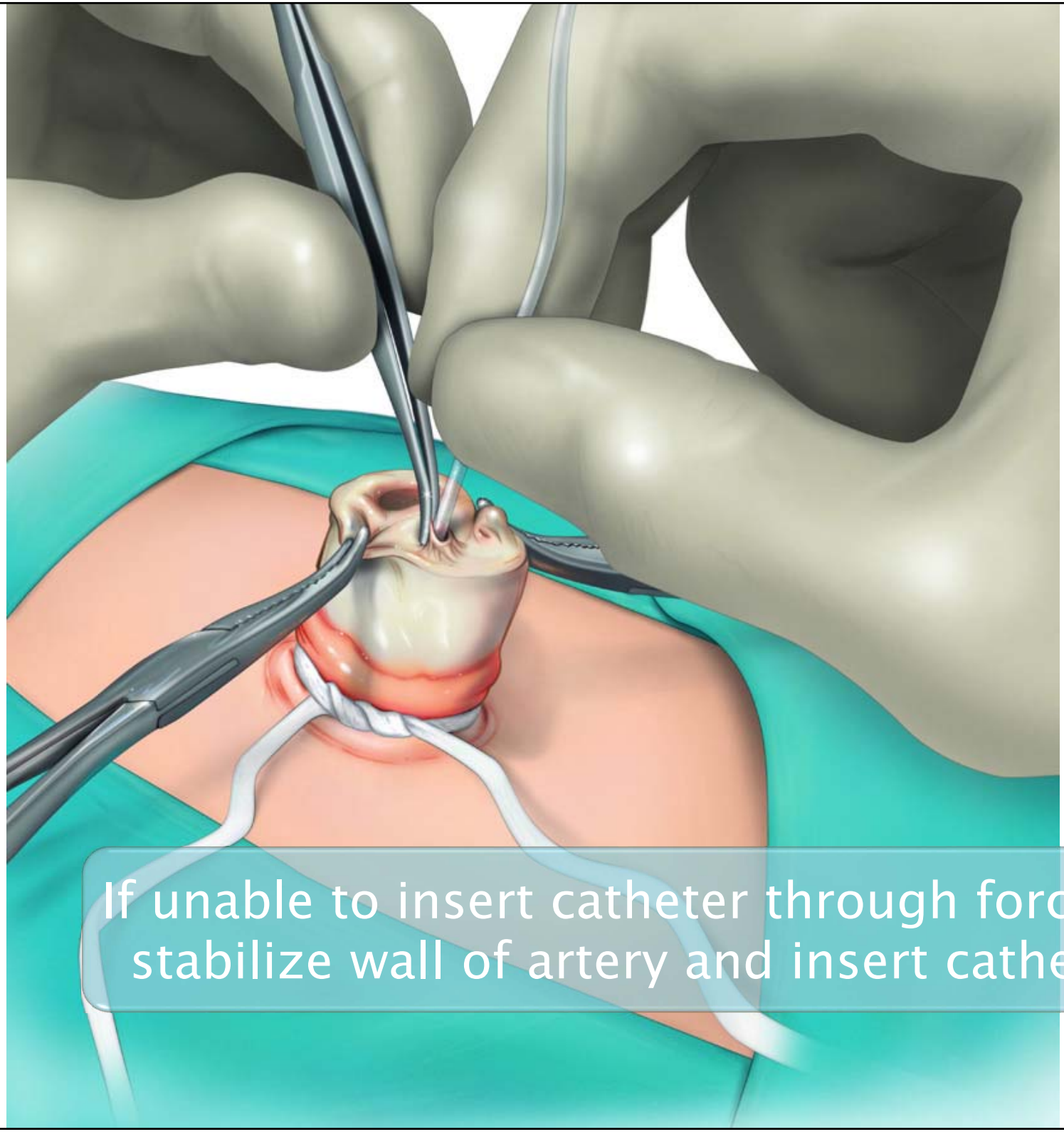
Securely hold umbilical cord through Wharton's jelly with curved hemostats



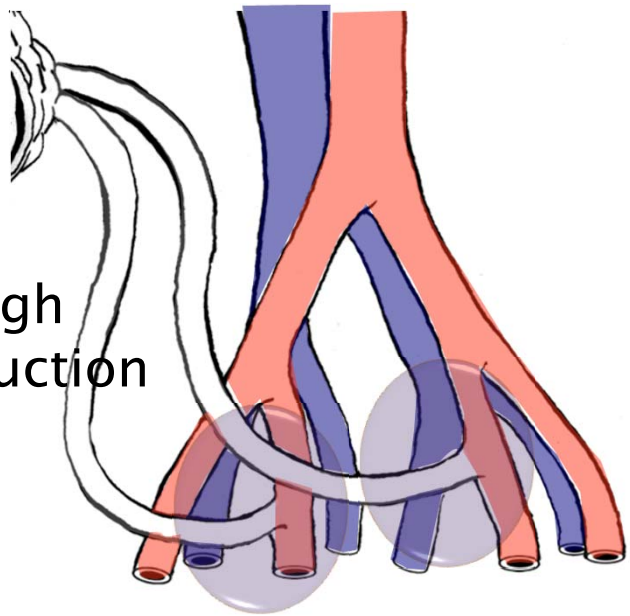

Gently insert one prong of curved iris forceps
Allow artery to dilate for 15 to 30 seconds


If possible gently spread the iris forceps

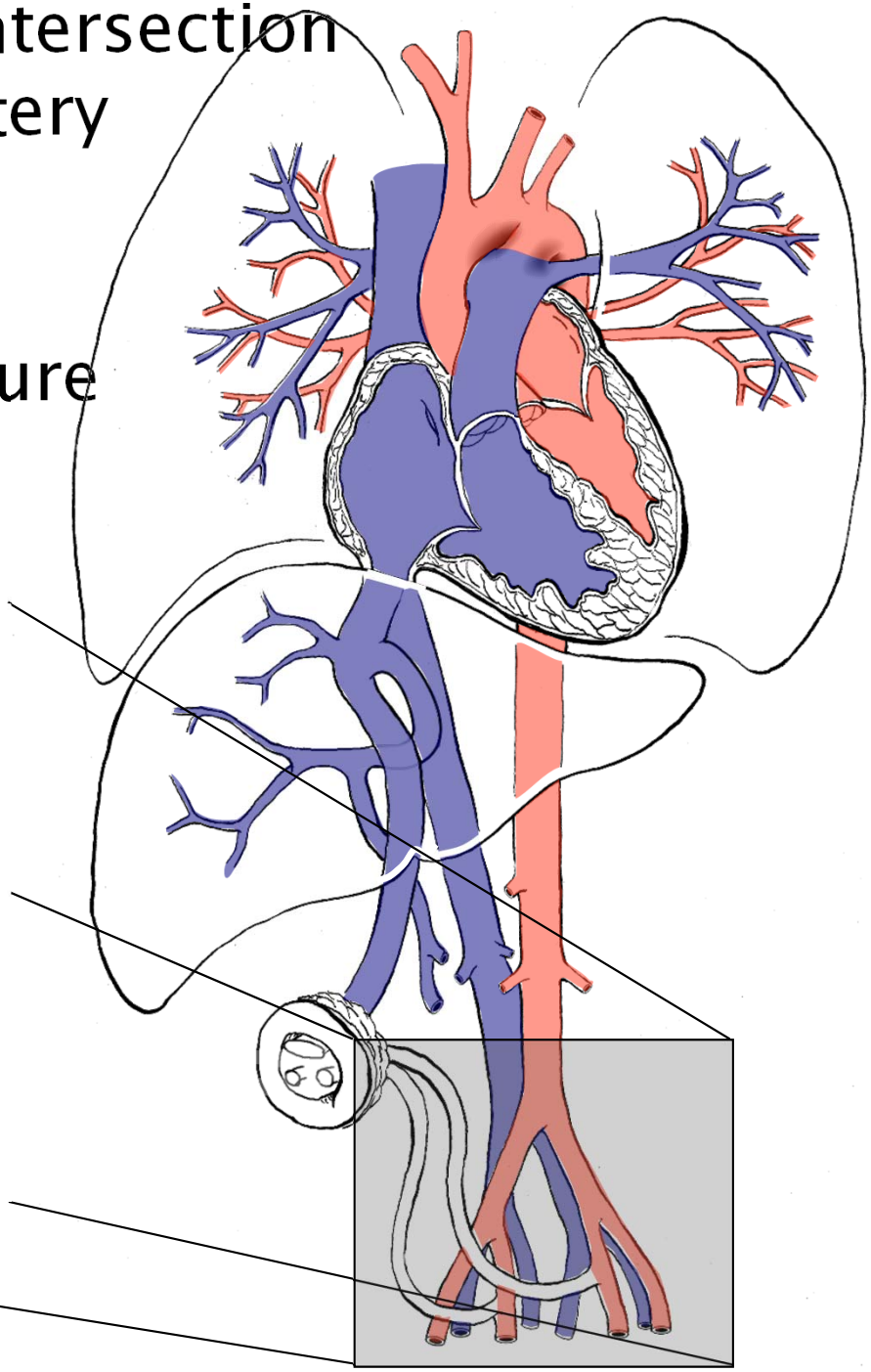

If possible insert catheter
through spread iris forceps


If unable to insert catheter through forceps, stabilize wall of artery and insert catheter

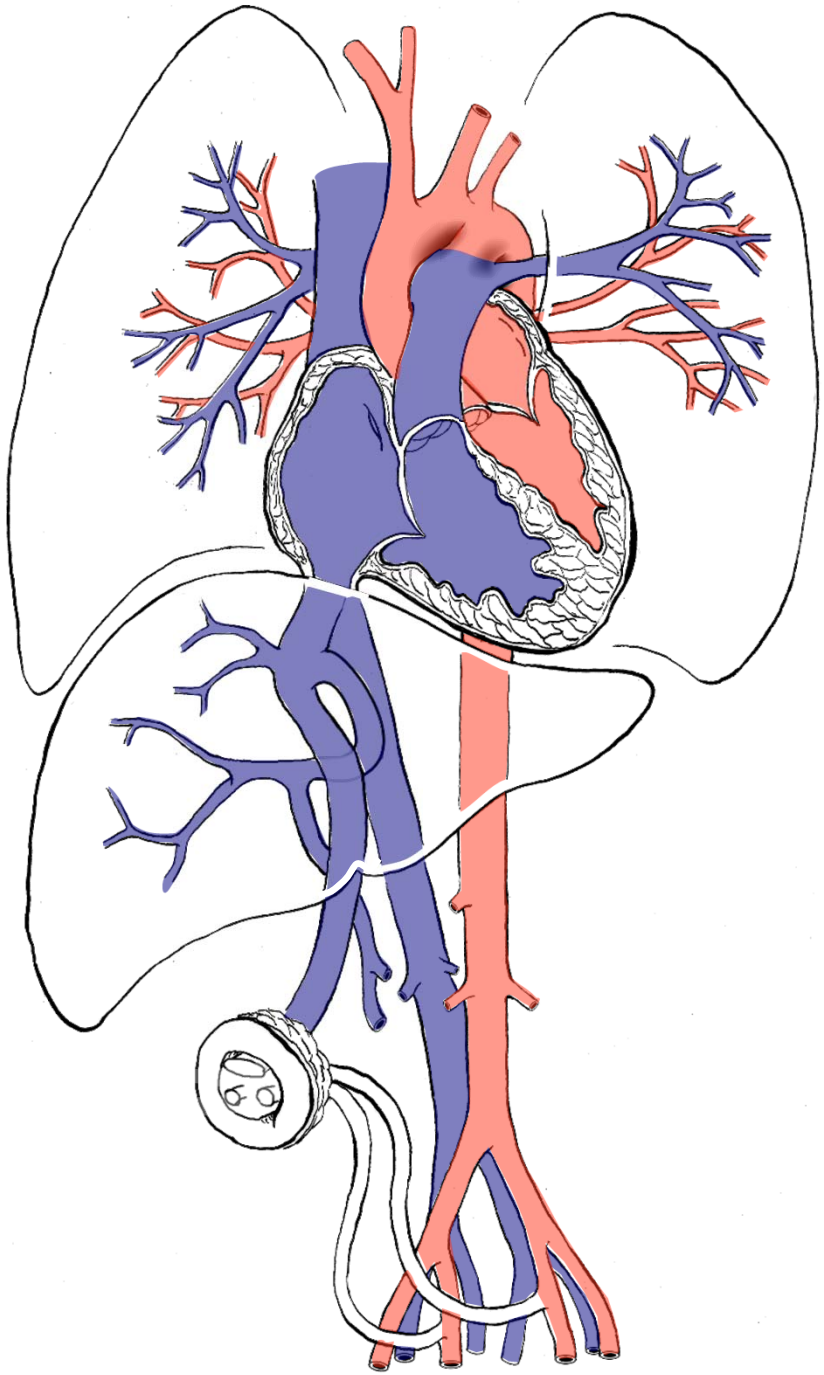
- Resistance may be met at intersection of umbilical artery / iliac artery → approximately 6 – 8 cm from umbilical stump
  - Apply steady gentle pressure for 30 – 60 seconds



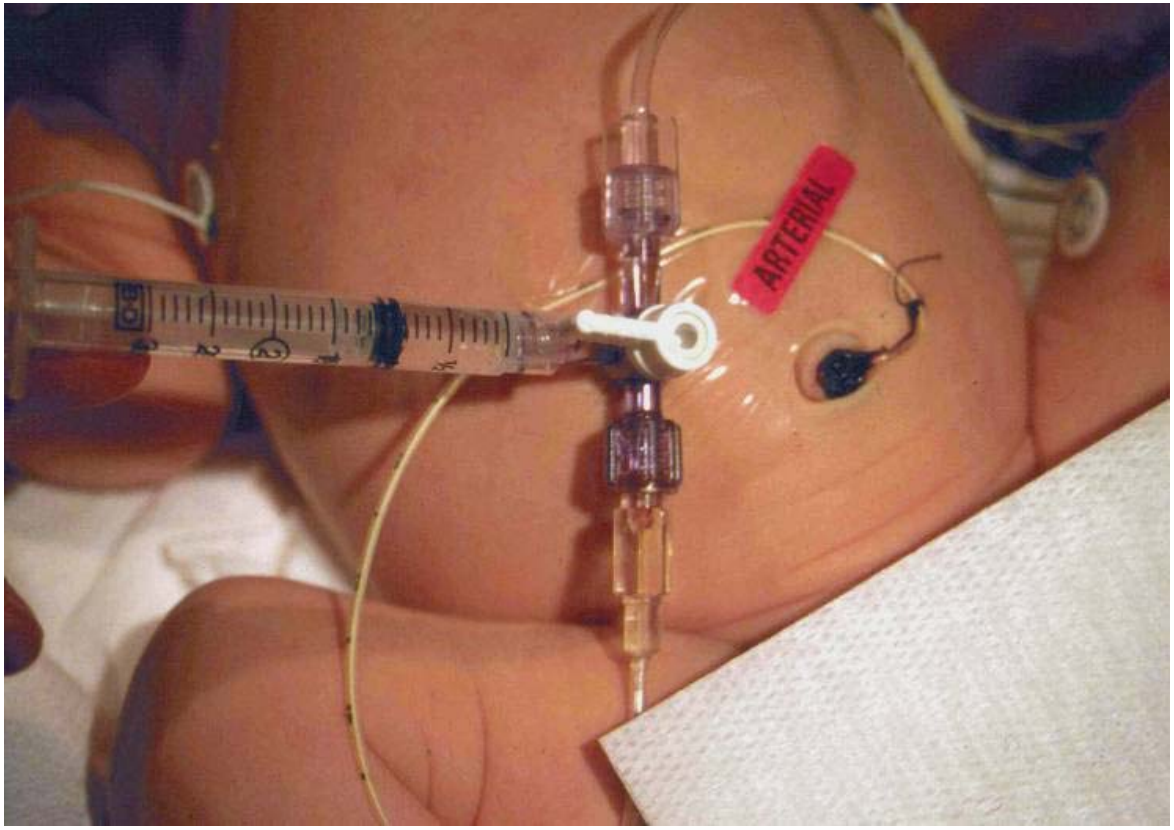
Do not force catheter through areas of obstruction



- Forcing catheter through area of resistance often results in false luminal track
- A ‘popping’ sensation usually indicates catheter in false track



- Insert catheter to appropriate distance
- Suture catheter through Wharton's jelly, not skin
- Use sterile water to remove antiseptic solution
- Secure catheter with surgical dressing
- Apply a label to identify the line is arterial

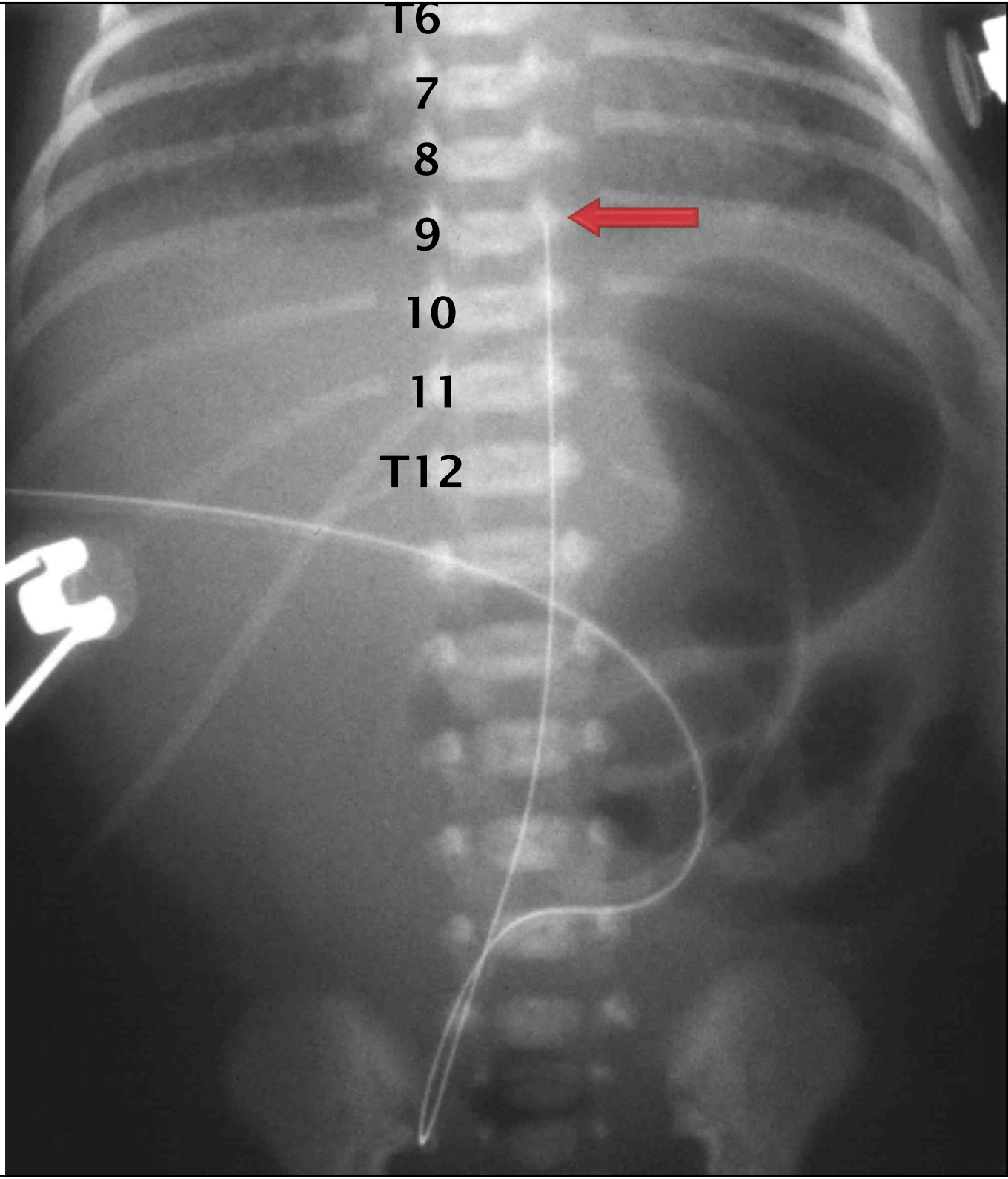


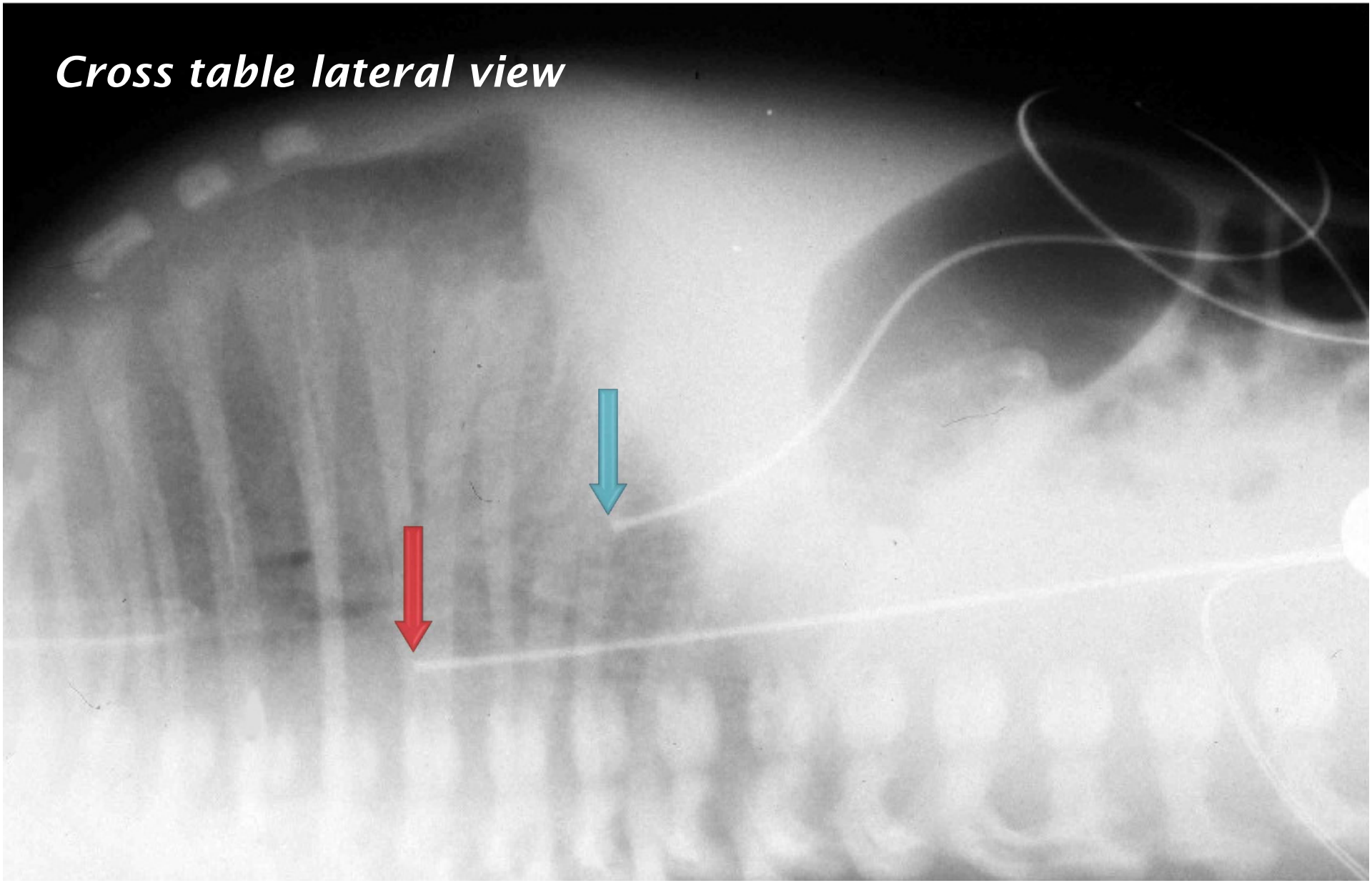
Do not advance catheter once sterile field disassembled

Remove catheter if:

- Tip is not in correct position
- There is no blood return once inserted
- There is evidence of vasospasm – check buttocks, feet/toes

UAC tip in good position at T9





UAC (red arrow) → note pathway along spine
UVC (blue arrow) → pathway more superficial