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# Central venous catheters in children and neonates – what is important?

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## Abstract

Central venous access is an essential part of perioperative management for infants and children undergoing cardiac surgery for congenital heart disease. In addition, a thorough knowledge of the techniues for cannulation and placement of venous lines from the various percutaneously accessible sites is an important aspect of cardiac catheterization in this patient population. In the first of a series of papers describing the various approaches to venous access, we describe percutaneous cannulation of the subclavian vein. The standard approach, as well as potential difficulties, and how to overcome them, are described, as also the complications associated with this approach.

**MeSH:** Catheterization, Central Venous/adverse effects/*methods; Venous Thrombosis/*prevention & control; Subclavian Vein

## Introduction

Central venous lines are essential in anaesthesia for major surgical procedures, for treatment in the ICU as well as for nutrition and drug administration in patients with enteral malnutrition or malignancy.

The most common insertion sites are the access via the femoral vein , the internal jugular vein and the subclavian vein. In addition in neonates, there are possibilities for peripheral access with long line silastic catheter via the cubital or the saphenous vein. In situations with extremely difficult venous status – very often after multiple previous central venous punctures and subsequent thrombosis – further possibilities include the transhepatic approach and direct right atrial catheter insertion during surgery.

In this series of articles we will focus on the technique and tips for catheter insertion at different sites including their specific problems. A detailed discussion of complications of central venous catheters in critically ill children may be found in recently published studies and reviews.[1–3] The first of this series of articles describes subclavian vein cannulation.

1. Problems with central venous catheters are of different types:
2. Difficulties and complications during insertion
3. Maintenance problems:
    1. Catheter related infection/ sepsis
    2. Central venous thrombosis
    3. Catheter obstruction
    4. Mechanical lesions during long term use

## Risk factors for infections

Infectious complications are frequent and are mainly related to the duration of indwelling time, younger patient age, the use of extensive guidewire exchange during repositioning or replacement of the central line, and techniques of handling/maintenance of the indwelling catheter.[1,4] Adherence to strict protocols have reduced the incidence of infections. Sterile catheterisation preparations are a prerequisite (Fig. 1).

Fig. 1 Sterile preparation

In infants and children, the insertion site seems to have no influence on the infection rate, as opposed to adults, in whom subclavian vein catheters have the lowest risk for infection. Antibiotic prophylaxis is debatable; with one prospective study showing better results after a single shot antibiotic prophylaxis for surgical patients. Continuous antibiotic prophylaxis is not recommended from the available evidence, but is often practised. Subcutaneous tunnelling for prevention of central venous line - related complications is recommended for long term use of central venous catheters.[1]

## Risk factors for venous thrombosis

Many venous thromboses remain subclinical, which is why the reported incidence varies widely. Some centres perform routine ultrasound, others only look for clinical signs of thrombosis. Thrombosis is associated with multiple attempts at insertion, bigger catheters, and pre-existing diseases like malignancy. The risk of thrombosis increases with duration of indwelling catheters. Heparin infusion seems to prolong the use of peripherally inserted central venous catheters in neonates, but no recommendations can be made on an evidence based level for lines directly inserted into large central veins. The potential risk of heparin-induce thrombocytopenia – even if very rare in children – should be considered. Clearing the catheter with urokinase or alteplase is a common practice. Heparin coated catheters also seem to have an advantage, but they are much more expensive.

## Central venous catheters: subclavian access

Subclavian central venous catheters in adults are known to have the lowest infection rate.[6,7] This however is not proven in children.[1,4] In experienced hands the subclavian access is still frequently used despite potentially having the highest rate of serious complications (pneumothorax and hematothorax). Unfortunately subclavian vein catheterisation under ultrasound guidance is very difficult and has yet not come into routine clinical practice. Scrupulous attention to technique and detail are therefore mandatory.

## Catheter equipment

The most common catheterisation technique is the Seldinger technique. Different products are available. In very small infants the very often used J-shaped guidewires are disadvantageous, and straight guidewires with a soft tip may be used.[5] The size of the catheter inserted should be minimized as far as possible, because thrombosis increases with size.[1]

## Landmarks

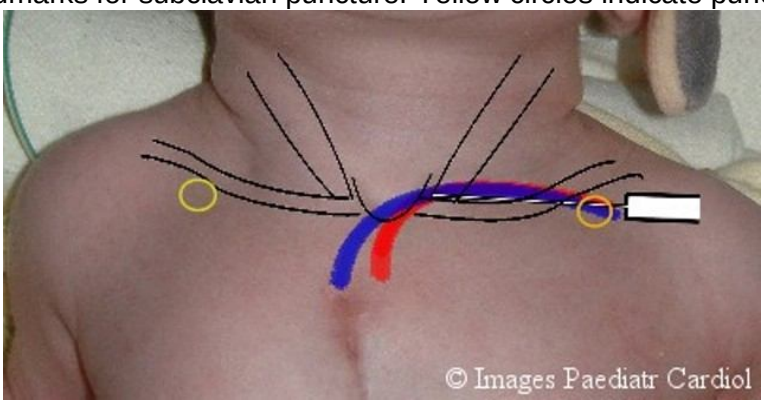
As shown in Fig. 2 the subclavian vein passes behind the clavicle anterior to the subclavian artery towards the sternal notch. The puncture site (yellow circles) is in the middle of the clavicle or slightly lateral and about 1 cm below.

The needle should then be directed towards the sternal notch at a very flat angle. If the puncture is performed at a too steep angle, the risk of hitting the artery or even the lungs is increased. If the primary puncture is unsuccessful, then the the needle can be positioned slightly steeper and a little more cephalad.

## Catheter position

The catheter position should be in the right atrium or in the superior vena cava. Some case reports of atrial perforation have led to the recommendation for positoning in the superior vena cava. The catheter length should be estimated in advance and the final position confirmed by X-ray. During insertion an atrial ECG recording connected to the central venous line or the guidewire may be used, but are not standard practice.[8]

Fig. 2 Landmarks for subclavian puncture. Yellow circles indicate puncture sites.




## Positioning of the patient

Appropriate positioning is extremely important. The key points are:
A shoulder roll should expose the chest thereby keeping the shoulders down. An outward rotation of the arms further improves this position. The baby can easily be fixed in this position with a towel (Fig. 2). An alternative is a longitudinal towel between the shoulders.
The chest is now elevated, but good venous filling requires either liver compression for increasing the central venous pressure – sometimes combined with an elevated PEEP on the ventilator - or the classical Trendelenburg positioning (Fig. 3).

Fig. 3 Positioning of the infant


Tilting the bed or operation table often results in adequate compensation of the effect of the shoulder roll for the operator (figure 4 shows clearly, that the chest is in a horizontal position).

Fig. 4 Trendelenburg position

**Puncture technique**

The skin needs cleaning and disinfection. A sterile drape should allow visibility and palpation of the sternal notch and the clavicle. A very helpful technique is palpation of the sternal notch with one finger and palpation of the clavicle with another. Then the puncture can be done under close guidance of the finger tip which helps to push the needle below the clavicle. (Fig. 5 & Fig. 6)

Fig. 5 Drapes and palpation. A) finger in the sternal notch; B) finger on the clavicle

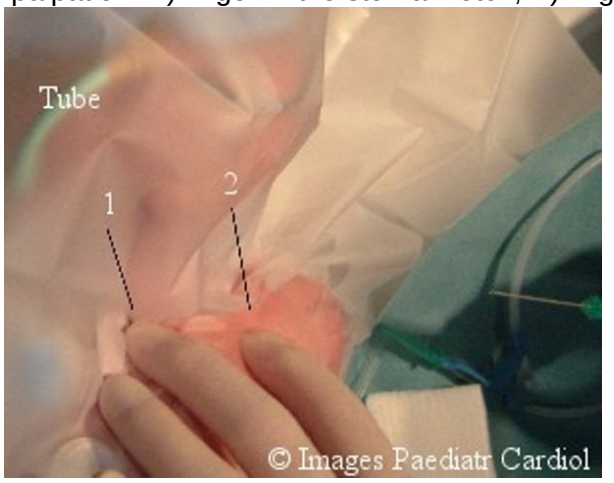



Fig. 6 Puncture.


While advancing the needle attached to a syringe slight aspiration should be performed. In many cases blood can be aspirated only when pulling the needling slowly backwards (during advancement the vein may be compressed or already perforated and transfixed). If there is now positive intra-thoracic pressure (in ventilated children) the puncture can also be done without syringe and aspiration. The author prefers to do this procedure without saline in the syringe. This allows better discrimination between venous and arterial blood.

As soon as blood can easily be aspirated the guidewire can be threaded through. Even if it would be possible to dilate the skin without incision it is preferable to incise to avoid damage of the catheter tip. A smooth and undamaged catheter is an important factor to prevent the adhesion of thrombocytes and consequent infection (fig. 7 & Fig. 8).

When pushing the catheter over the guidewire it should always be manipulated very close to the skin to minimize any possible catheter and guidewire kinking. Finally every catheter must be fixed – best done by suturing (Fig. 9 & Fig. 10).

Fig. 7 Incision

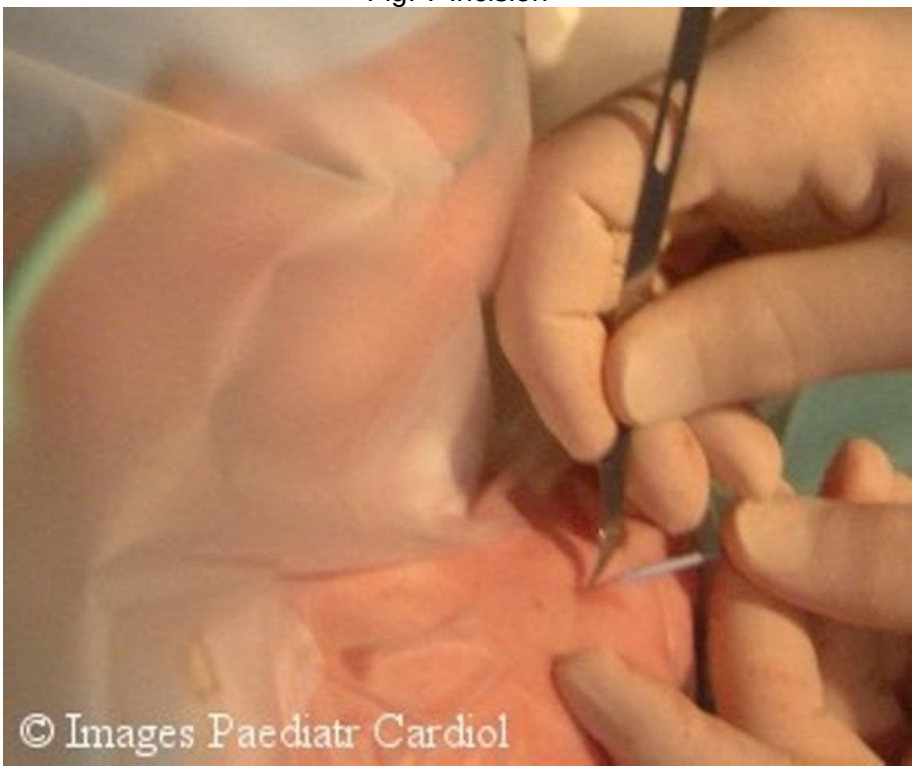
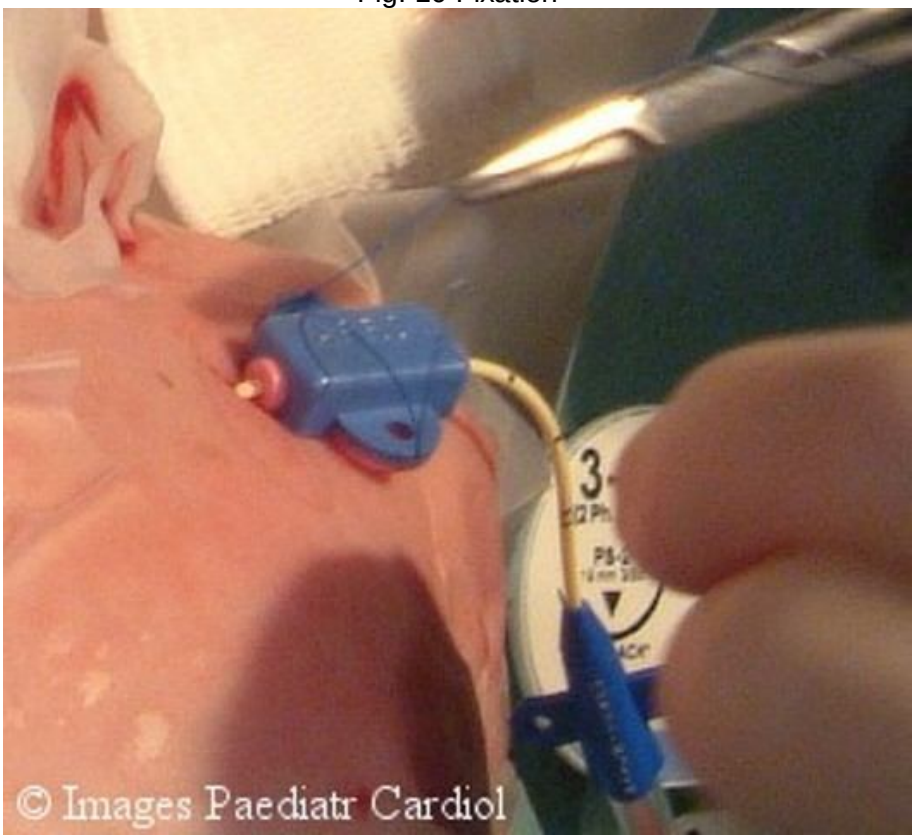



Fig. 8 Dilator over guidewire

Fig. 9 Catheter advancement


Fig. 10 Fixation




## Complications

The overall complication rate is reported to be around 4%.[1] Serious problems are the pneumothorax and hematothorax. Malpositioning is the most common problem with migration of the catheter to the contralateral subclavian vein or – more frequently – to one of the internal jugular veins. This problem appears to be more common when the catheter is inserted from the right side.[1,9]

## Conclusion

The advantage of the subclavian access for central venous catheters is its good fixation, ease of access and use, and minor infection rate at least in older children. As the rate of serious complications and malpositioning is higher compared to the internal jugular and femoral approach this access should be performed by experienced staff.

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