

# Ultrasound-guided Central Venous Cannulation in Infants

**Christian Breschan, MD, DEAA  
Anaesthesia, Klinikum Klagenfurt  
Klagenfurt, Austria  
breschan.ch@chello.at**

## **Introduction**

US-guided central venous cannulation has been recommended in children since 2002 (1).

## **Methods**

The US-guided cannulation has been described in children for the internal jugular, subclavian, brachiocephalic and femoral vein (2 - 11). Studies comparing the landmark with the US-guided technique exist in children only for the internal jugular and femoral vein (2, 3). They clearly favour the US-guided technique in terms of quicker and higher success rates and fewer puncture complications. Nevertheless a meta-analysis in 2009 did still not provide the evidence in favour of the US guided cannulation method for the internal jugular vein in children (12). This result, however, seems to be skewed by one single study which showed the total opposite while having included the largest number of infants (13).

## **Risk reduction of puncture complications**

The most important issue is the reduction of required puncture attempts, a number which increases significantly with decreasing body weight (14, 15, 16). In addition to optimal positioning, deep sedation, correct choice of the vein and cannulation material the US guided cannulation seems to be the best option for reducing the number of cannulation attempts. Ultrasonography enables the view under the skin. Thus the anatomy of vessels of any patient can be viewed, the cannulation technique can be adjusted and the needle can be precisely directed above all when the IP technique has been applied.

## **OOP (Out-of-plane) – IP (In-plane) technique**

The OOP cannulation of the internal jugular vein is technically easy. However, the tip of the needle is usually only seen indirectly by tissue and vessel wall compression and in infants a complete vessel collapse by the approaching needle is always observed. This is also true of the femoral vein.

As opposed to this the supraclavicular IP cannulation of the subclavian or brachiocephalic vein by the use of an US probe placed in the supraclavicular region usually provides an excellent view of the advancing needle including the surrounding tissue structures over the entire distance (5 – 9). In addition the subclavian and brachiocephalic vein do not collapse upon the needle approachment as they are fixed to the clavipectoral fascia. However, this method requires a perfect alignment of US probe, vessel and needle as outlined later (16). When using this approach the cannulation of the left brachiocephalic vein is easier than that of the right one. The left brachiocephalic vein runs nearly horizontally whereas the right one takes a steep caudad run which sometimes makes a good view as obtained of the longitudinal extension very difficult.

The subclavian vein can also be punctured from the infraclavicular region by a probe placed supraclavicularly (4). However, this leads to a disturbing ultrasound shadow of the clavicle as the advancement of the needle cannot be seen over this distance.

## **Availability of US devices**

US devices are expensive. A small reliable device may cost between 30.000 and 50.000 Euros. This is a major burden for poor countries. This is mainly why the Landmark technique can still not be completely neglected.

### **Training**

The US guided technique requires a good understanding of the anatomy as well as sono-anatomy plus a good hand-eye coordination. An excellent hand-eye coordination and immobile needle technique without attached syringe is in particular important for the IP technique as this requires that the needle be located inside a 1mm longitudinal area of the long axis of the US probe (16). Only slight deviations in a lateral direction can cause the needle to disappear from the US window. Reliable recognition of sonoanatomic structures combined with a good hand-eye coordination requires an intense training.

### **Recognition of puncture complications**

As opposed to avoiding inadvertent arterial punctures the use of US may not be very helpful in terms of reliably detecting an accidental arterial puncture when it has taken place in a neonate. The pulsatile movements of an artery may be difficult to view in an extremely small baby. In addition the exact sonographic location of an introduced guide-wire or catheter can be difficult as these devices often run side by side with the vessel wall. On the other hand there is no doubt that US provides the most sensitive method to detect a pneumothorax of a patient in the supine position (17). The bed-side diagnosis of a pericardial effusion via US is also a quick option.

### **Conclusion**

The location, size and patency should always be determined before the cannulation of any deep central vein. Due to higher success rates and reduced puncture complications in infants the US guided cannulation technique must therefore be regarded as the method of choice in these patients. In addition US enables the quick diagnosis of puncture complications. Three relevant restrictions of US guided cannulations are:

- availability of an US device
- physically limited view e.g. by air
- intense training required.

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