*Acta Anaesthesiol Scand 2002; **46:** 390–392*
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ACTA ANAESTHESIOLOGICA SCANDINAVICA
0001-5172

Ultrasound-guided central venous cannulation in infants and children

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Background: Percutaneous central venous cannulation in infants and children is a challenging procedure. Traditionally, an external landmark technique has been used to identify puncture site. An ultrasound-guided technique is now available and we wanted to evaluate this method in children and infants, looking specifically at the ease of use, success rate and complications.
Methods: Forty-two consecutive infants and children (median 16.5 [0–177] months and 10 [3–45] kg) scheduled for central venous catheter placement were registered. An ultrasound scanner made for guiding puncture of vessels was used. After locating the puncture site, a sterile procedure was performed using an accompanying kit to aid puncture of the vessel.
Results: Cannulation was successful in all patients and we had no complications during insertion of the catheters. The right internal jugular vein was preferred in most patients, and in 95% of the patients the vein was punctured at the first attempt. The median time from start of puncture to aspiration of blood was 12 (3–180) seconds.
Conclusion: The ultrasound-guided technique for placement of central venous catheters was easy to apply in infants and children. It is our impression that it increased the precision and safety of the procedure in this group of patients.

Received 28 June, accepted 14 September 2001

Key words: central venous catheter; children; external landmark technique; infants; ultrasound-guided technique.

Percutaneous central venous cannulation is associated with a number of potential complications (1–4). The success rate is lower and the complication rate higher in infants and children than in adults (5, 6).

The use of an ultrasound-guided technique has been shown to increase the success rate and decrease the incidence of complications associated with central venous cannulation (1–4, 6). However, the technique is not well known and not widely used by European anesthesiologists. Our aim with the present investigation was to evaluate the ease of use, success rate and complication rate of this technique in infants and children.

Material and methods

Ultrasound-guided central venous cannulation was prospectively studied in 42 consecutive infants and children scheduled for central venous access due to major surgery, intensive care treatment, difficult peripheral venous access or long-term intravenous treatment. We did not regard it as necessary to get informed parental consent because this method is a well-established procedure and has been in use for several years.

General anesthesia was preferred in all but one patient and either a 4 or 5 Fr. double lumen central venous catheter (Arrow International, Reading, PA, USA) was chosen based on the patient's age. We used a Site Rite ultrasound 9 MHz scanner (Bard Access Systems, Salt Lake City, UT, USA) designed for imaging and guiding puncture of vessels. To obtain a sterile field during the procedure it is important to use the accompanying Needle Guide Kit, which contains sterile conductive gel, one polyethylene sheath, two elastic bands and one set of needle guides. The kits are available for 18-, 20- and 21-gauge needles.

Before the sterile procedure was performed, we measured the depth, size and position of the vein. The vein should be compressible by gentle pressure of the probe on the skin, and pulsation of the carotid artery should be observed.

After deciding the puncture site, the area was washed and draped. Conductive gel was put inside the sterile sheath, the probe inserted, and the appropriate needle guide connected to the ultrasound probe. Sterile conductive gel was applied on the skin and a small skin incision was made to ease the inser-

tion of the needle through the skin. The vein was visualized and the depth markers, which show the needle direction on the ultrasound screen, were centered in the middle of the vein. When the needle was advanced, the anterior wall of the vein was compressed. After perforation of the wall, the vein regained its circular shape and blood could be aspirated into the syringe. Probe and syringe were removed and a guide wire advanced through the needle into the vein. The procedure was completed with standard Seldinger technique and chest X-ray was regularly used to confirm catheter placement and to detect complications.

Age, bodyweight, indication for CVC, access site, duration of CVC use and the time from first attempt to puncture the vein and until blood was aspirated were recorded.

Results

Cannulation was successful in all patients (median 16.5 [0–177] months and 10 [3–45] kg) and we did not have any complications during placement of the catheters. In 40 out of 42 patients the vein was punctured at the first attempt. Median access time, from when the needle penetrated the skin to aspiration of blood, was 12 s (3–180). In the patient in whom 120 s elapsed before aspirating blood, the needle was too short and had to be replaced with a longer needle. Median duration of the CVC was 11 days (4–25). The right internal jugular vein was cannulated in 37 patients. In three patients, the left internal jugular vein was used, because of threading guide wires when puncturing the right internal jugular vein. The femoral vein was preferred in one child with retropharyngeal infection and in one neonate with complex congenital heart disease and a congenital diaphragmatic hernia.

Discussion

Our results show that it was easy to confirm patency, identify and puncture the vein with the use of the ultrasound-guided technique. It is also noteworthy that we had no complications during the procedure. Although previous publications have shown this technique to be superior to the landmark technique (1–3, 5, 6), our experience is that it is not well known or widely used by anesthesiologists.

The major advantage with the ultrasound-guided approach is the ability to visualize the structures at the puncture site before cannulation is attempted. We could measure the depth, size and intraluminal conditions of the vessels. Anatomic variations and the relation to the artery could be seen. It is not unusual that the internal jugular vein is partly or fully superficial to the carotid artery (7) and this makes accidental arterial puncture a possible risk if the needle traverses the internal jugular vein. We found it easy to differentiate between the artery and the vein, because the vein was compressible by gentle pressure from the probe on the skin, and pulsations could be observed from the artery. Verghese et al. (6) have shown significantly lower cannulation time and reduced incidence of carotid artery punctures in infants and children, using the ultrasound technique compared to the landmark technique. A meta-analysis in adults (3) found that compared with the landmark technique, ultrasound guidance increased the probability of successful catheter placement, reduced the number of complications encountered during catheter placement, and decreased the need for multiple catheter placement attempts.

Particularly in cannulations of infants, it was difficult to observe the needle perforating the anterior wall of the vein. In infants and small children, we used a transfixation technique in which we deliberately perforated the posterior wall of the vessel. To avoid accidental pneumothorax, we directed the needle nearly perpendicular to the skin. After probe removal, the needle was slowly retracted until blood was aspirated into the syringe.

Furthermore, we had some difficulties in advancing the guide wire into the vein. This is a known difficulty when the landmark technique is used. This problem occurred particularly in infants when the curved end of the guide wire was used. We therefore changed to the soft straight tip, which made insertion easier. Only a small movement of the needle may lead to needle displacement in infants. To avoid this, a colleague inserted the guide wire while the operator was stabilizing the needle.

Conclusion

The ultrasound-guided technique for placement of central venous catheters was easy to apply in infants and children. It is our impression that it increased the precision and safety of the procedure in this group of patients.

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