

Central Venous Catheter Misplaced in the Innominate Vein after Penetrating the Left Subclavian Vein in a Neonate

– A Case Report –

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In the pediatric ICU and operating room, a central venous catheter (CVC) provides accurate hemodynamic information and serves as a reliable route for the administration of vasoactive drugs, fluids and allogeneic blood products. The placement of CVC is associated with a complication rate of 0.4% to 20%, including hemothorax, pneumothorax, thrombosis, infection and cardiac tamponade. We describe a case of CVC being misplaced in the innominate vein after penetrating the subclavian vein during anesthesia induction for arterial switch operation. Our report discusses the mechanisms by which this mishap took place, and reviews the proper positions of the head, arm, thorax and safe depth of venipuncture for the placement of a CVC in neonates.

Key Words: central venous catheter, misplace, neonate.

In the pediatric ICU and operating room, the placement of a central venous catheter (CVC) is essential in order to obtain accurate hemodynamic information, and for the administration of vasoactive drugs and fluids.[1,2] Additionally, current therapeutic techniques for the treatment of leukemia, the use of hemodialysis, and the need for long-term parenteral nutrition or antibiotic therapy require large-sized vessels with a high blood flow.

Predictable complications of central vein catheterization include arterial puncture, pneumothorax, air embolism, arrhythmia, malpositioning of the catheter and cardiac tamponade. Catheter malposition results in not only faulty central venous pressure measurement but also significant complications such as thrombosis, arrhythmia, cardiac perforation, and cardiac tamponade.[3-5]

CASE REPORT

A 6-day-old male neonate with transposition of the great arteries (TGA) presented for arterial switch operation. The baby, weighing 3.8 kg, was born by normal vaginal delivery at 39 weeks. The preoperative echocardiogram showed complete TGA, large patent ductus arteriosus and patent foramen ovale with left to right shunt. Preoperatively the baby had a heart rate of 162 beat/min, blood pressure of 70/40 mmHg, respiratory rate of 60 breaths/min, sinus cardiac rhythm and an oxygen saturations of 85% at room air. Assisted ventilation was started via facemask with 100% oxygen, and 5 mg ketamine was administered intravenously for anesthesia induction.

Intubation was easily achieved with 3 mg rocuronium intravenous injection, and anesthesia was maintained with 1.5% sevoflurane and 1 μ g per hour fentanyl infusion. Oxygen saturations after intubation was between 93% and 96% with 50% oxygen.

The baby was placed in a 15° head-down position with a rolled towel placed transversely under the shoulder, thereby extending the neck, causing the thoracic cavity to protrude. The arm was adducted and stretched towards the foot. The baby's head was turned to face away from the puncture side. The skin

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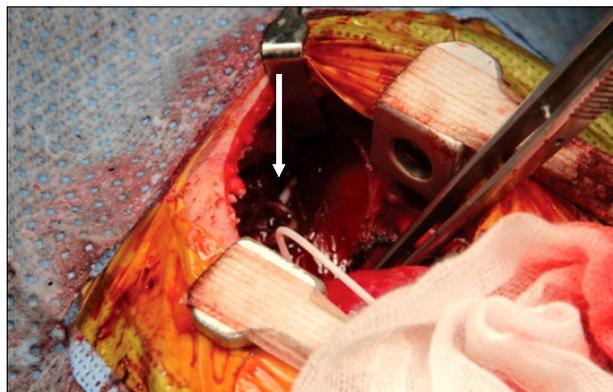


Fig. 1. Central venous catheter misplaced in the innominate vein after penetrating the left subclavian vein (arrow).

was punctured 1 cm caudad to the distal third of the clavicle. The left subclavian vein was entered with a 22-gauge introducer needle and penetrated to a depth of 3 cm. A return of dark nonpulsatile blood was seen and a guidewire was passed smoothly through the needle. A small skin nick around the guidewire was made and a 5 Fr dilator was passed over the guidewire and then withdrawn. A 4 Fr catheter (Polyurethane catheter, BD Careflow™, Singapore) was then inserted over the wire, and blood return was obtained with both ports.

Both the anesthesia and surgery continued uneventfully. After sternotomy for the cardiac operation, it was realized that the CVC had been misplaced into the innominate vein after penetrating the left subclavian vein (Fig. 1). Fortunately, there was no hemothorax and a transesophageal echo image showed that the CVC tip was in the right atrium. After the main surgery procedure, the surgeon placed another CVC in the right atrium.

The patient was transferred to the pediatric ICU, still intubated, and ventilated. His clinical course was unremarkable, and the mechanical ventilation was discontinued 43 hrs later. Chest radiography was done daily to observe any change in the CVC position and fortunately, there was none. A week later, the CVC was carefully removed and bleeding was not observed. Twelve days later, he was discharged from the hospital without any complications.

DISCUSSION

In children, the placement of central venous catheters can be performed through various veins, such as the femoral vein, internal jugular vein, and brachial vein.[6-8] The subclavian vein is one of the most frequently used central venous routes in pediatric patients. The subclavian vein's skin puncture site is less

likely to become infected than the other veins' puncture sites, and the patients are free to move their arms and heads.[9,10] In addition, the subclavian vein catheter can be placed without disrupting airway management during the initial stage of resuscitation. Mechanical complications, such as pneumothorax and hematoma, are infrequent, with rates between 1.5% and 3.1% and 1.2% and 2.1%, respectively.[11]

Usually for subclavian central access in adult, the patient is placed in slight Trendelenburg position with the arms fully adducted and the head turned slightly away. A small towel roll is placed between the shoulder blades to fully expose the infraclavicular area. The skin is punctured 2 to 3 cm caudad to the midpoint of the clavicle, far enough from its inferior edge to avoid downward angulation of the needle as it is inserted just beneath the posterior surface of the clavicle. The needle tip is aimed toward the suprasternal notch, which may be constantly identified by the fingers of the operator's other hand.[12]

But the position and puncture site for subclavian central access in children are significantly different from adults. Especially, in neonates, the choice of position and puncture site for subclavian central access is very important because the various complications associated with subclavian catheterization frequently occur. The pediatric patient is placed in the Trendelenburg position with a towel roll placed under the thoracic spine to hyperextend the back. The skin is punctured 0.5 cm to 1 cm caudad to the distal third of the clavicle. The needle tip is aimed toward the suprasternal notch.[13]

In this case, the subclavian vein puncture was performed in the same way. In addition to this position, the arm was adducted and stretched towards the foot to aid in exposing the clavicle. Dark non-pulsatile blood return was noted at an introducer needle depth of 3 cm. However, the CVC had been misplaced into the innominate vein after penetrating the left subclavian vein.

Several mechanisms causing the misplaced CVC in this case have been suspected and these are the adducted and stretched arm, a more distal puncture site and introducer needle depth of 3 cm (Fig. 2).

As shown in Fig. 2, an excessive stretching of the arm can induce angulation of the subclavian vein which is probably the main cause of our CVC malposition. Distal puncture site is another suspected reason for the malposition and can also cause a subclavian artery puncture.

If the CVC catheterization was performed with sono-guidance, we could have visualized the tip of the introducer needle early on and avoided the misplacement of the catheter. The use

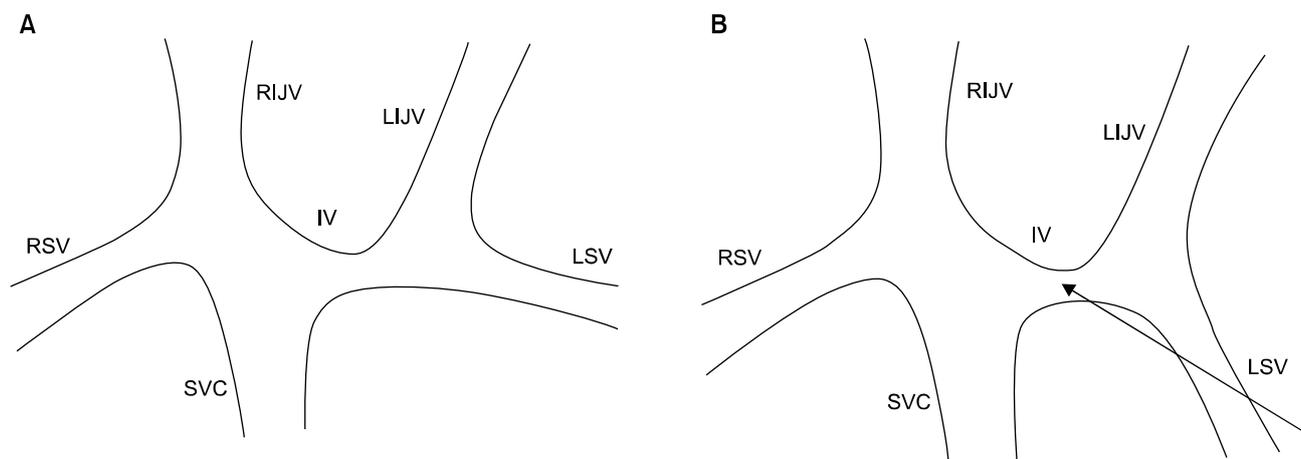


Fig. 2. Mechanism involved in central venous catheter being misplaced into the innominate vein after penetrating the left subclavian vein. IV: innominate vein; RIJV: right internal jugular vein; LIJV: left internal jugular vein; RSV: right subclavian vein; LSV: left subclavian vein; SVC: superior vena cava. (A) Normal anatomy of the subclavian vein and innominate vein. (B) Probable route of the introducer needle.

of an ultrasound-guided technique has been shown to increase the success rate of CVC catheterization in children.[14,15]

Since the postoperative care of this CVC was important after the operation, chest radiography was done daily to observe for change in CVC position and hemothorax. This CVC was carefully removed by the anesthesiologist and surgeon after a week, since the one week delay offered enough time for tissue healing.[16] In view of our experience, when a subclavian approach for central venous cannulation is chosen for neonates, extra caution should be observed to avoid excessive stretching of the arm, a more distal puncture site and inappropriate depth of the introducer needle. When a malpositioned CVC has been discovered, the treatment should include monitoring of hemodynamic stability, chest radiography and avoiding the abrupt removal of the CVC.

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