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Central venous catheterization for infants with breakage of the guidewire: a case report and literature review

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Abstract

Background/Objectives: Central venous access is an essential part of neonatal care. In addition, a thorough knowledge of the techniques for cannulation and placement of venous lines **Methods/Statistical analysis:** We describe percutaneous cannulation of the subclavian vein and case of breakage of guidewire during cannulation in a infants and describe the condition**. Findings**: It showed that the distal portion of the guidewire had been cut and left twisted under the clavicle. The tip of the guidewire was found in the tissue below the subclavian vein and surgically removed. **Improvements/Applications:** The standard approach, as well as potential difficulties and other considerations are described with literature review.

Index Terms

central venous catheterization, children, complications, subclavian vein, premature

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I. INTRODUCTION

In pediatric patients, central venous catheterization (CVC) is useful for hemodynamic measurements, such as central vein pressure, collection of blood for clinical tests, and the route of administration of fluids, blood, various drugs, and long-term total parenteral nutrition (TPN) [1]. Particularly, in premature infants, it is an essential technique used for special purposes, such as parenteral hyperalimentation, exchange transfusion, and plasmapheresis [2,3].

Insertional sites that are used in adults can also be used in children. Access to the central circulation can be achieved from the internal and external jugular, subclavian, basilar, umbilical, and femoral veins. The site selected depends on the operator's experience and indication for the catheter.

Of all complications that occur during the insertion of a central venous catheter in children, 3%–6% are hematomas or arterial punctures [4]. Complications during the guidewire insertion process in adults include bending, knotting, and amputation [5,6]. Both premature and full-term infants have a higher incidence of complications because of the small anatomical size compared to adults.

In Korea, there have been reports of catheter sheath amputation in premature infants [7], but complications associated with the amputation of guidewires have not been reported. In this regard, we experienced an amputation of the distal end of the guidewire and surgical removal during CVC in a premature infant. Herein, we report the case with a literature review.

II. CASE

A boy weighing 800 g was born from vaginal delivery at 25 weeks of gestation and subjected to ventilator treatment inside an incubator. At 11 weeks of age, weighing 1,800 g, he was referred to the department of anesthesia and pain medicine for CVC. Preoperatively, risks of the procedure, such as hematoma, pneumothorax, hemothorax, and possibility of various complications, were explained to the caregiver, and consent was obtained.

Electrocardiography, noninvasive arterial pressure monitoring, and pulse oximetry were performed in the neonatal intensive care unit, and right subclavian vein (SCV) cannulation was planned. The patient's neck was extended using a rolled towel placed transversely under the shoulder area, and his head was rotated approximately 30° to the left. Right SCV catheterization was planned with a 4-Fr pediatric double-lumen central venous catheter (ARROWg + ard Blue®, Arrow International Inc., USA). A 21-G introducer needle was injected from the distal one-third portion of the right clavicle, and venous puncture was confirmed with blood aspiration. After slowly advancing a 0.018″ guidewire with a length of 13 cm, the puncture needle was removed, and catheter insertion was attempted carefully. However, upon advancing the catheter into the skin approximately 3 cm along the guidewire, resistance was felt, and the sheath was not advanced further. Assuming that the tip of the cannula sheath passed through the posterior wall of the SCV, the guidewire was pushed out together in the process of removing the catheter. Sufficient pressure was applied to the area from where the guidewire was removed, and subcutaneous bleeding or hematoma was not observed at the site. However, it was confirmed that approximately 5 cm of the distal portion of the guidewire that was pushed out was cut off. Subsequently, a simple chest X-ray scan was performed. It showed that the distal portion of the guidewire had been cut and left twisted under the clavicle (Fig. 1). After an incision of approximately 1 cm at the skin puncture site, we attempted to remove the remnant portion of the guidewire but failed. Finally, we decided to remove it surgically. Preoperatively, ultrasound was performed for the surface marked based on the chest X-ray. Surgery was performed general anesthesia for removal of the catheter. The tip of the guidewire was found in the tissue below the subclavian vein and surgically removed (Fig. 2).

Fig. 1. Chest X-ray of the patient. It shows a fragment of the guidewire.

Fig. 2. Surgically removed catheter fragment.

Ⅲ. DISCUSSION

Special care is provided to children, particularly underweight infants, in the neonatal intensive care unit. TPN is required for a long time period before oral nutrition intake is possible in underweight premature infants. In addition, CVC in premature infants has become an important part of patient care because it is used for infusion routes, such as fluids, drugs, and blood transfusions, and for various hemodynamic monitoring procedures

The relative indications for CVC are as follows: inadequate peripheral venous access, central venous pressure monitoring, infusion of various drugs, blood transfusion, and a planned operative procedure with a high risk for hemodynamically significant venous air embolism. There are no absolute indications for central venous pressure monitoring in children. However, compared to adults, CVC placement in children is technically more difficult and carries more risks.

Catheters of various sizes (2.5 to 10.0 Fr), lengths, and composition are available for pediatric applications. The selection of the catheter is based on the purpose of catheter use and size of the patient [8].

In children, as in adults, CVC is placed into the femoral, subclavian, and jugular veins [9-12]. Among various sites for cannulation, CVC placement in the subclavian vein showed a high success rate without significant complications in a study by Baer et al. in 1981, and it has been widely used after showing a 96% success rate without major complications using the Seldinger method in a study by Pybus et al. in 1982 [13,14].

As for the technical aspect, catheters are generally inserted with the Seldinger technique, using landmarks that are similar to those used in adults. All sites share the common complications of infection (site cellulitis and bacteremia), venous thrombosis with potential emboli, air embolism, catheter malfunction (occlusion, dislodgment, or fractures), dysrhythmias (when the catheter tip is in the heart), and bleeding. Universal precautions and sterile techniques should be used in CVC. Complications associated with catheterization usually occur during a central venous puncture. Complications during venous puncture include arterial puncture, tracheal puncture, pneumothorax, mediastinal emphysema, chylothorax, brachial plexus, or stellate ganglion puncture [15]. Complications during catheterization include intra-arterial insertion, heart damage, arrhythmia caused by the guidewire, and air embolism.

Particularly, complications associated with the insertion of the guidewire include knotting, bending, and cutting of the guidewire [16]-18]. When these complications occur in infants, they may be fatal, unlike those in adults. Attention should be paid to CVC, particularly for complications associated with the guidewire, because it poses a high risk of damage to the surrounding tissues or blood vessels during the removal process.

Performing safe CVC requires not only technical training but also the precise knowledge of the anatomy of the puncture site [19]. For the subclavian vein, as in our case, it is normally located in the middle-third of the dorsal side of the clavicle. To puncture the subclavian vein from this site, surgeons should aim for a short and narrow gap between the clavicle and the costoclavicular ligament, which is located on the medial side of the first rib.

Different products are available. In very small infants, the commonly used J-shaped guidewires are disadvantageous, and straight guidewires with a soft tip may be used. The size of the catheter inserted should be minimized as much as possible because thrombosis increases with size [20,21]. Currently, the guidewire, which is widely used in adults, has a double-wire structure, with a steel core in the center and coiled wire wrapping it from the outside, giving it flexibility and elasticity. In contrast, for children, the thin wire wraps around the central single wire, making it less elastic and thinner than the adult guidewire. This double-wire structure allows the guidewire to easily enter from one direction along the curved blood vessels. However, the surface is not smooth, so if excessive force is manipulated within the induced needle, the outer coiled wire and core wire may separate, causing the wire to bend or cut. In this case, although blood aspiration was confirmed upon the puncture, resistance was felt when inserting the guidewire. Further, after pulling it back by approximately 1 cm, the guidewire was inserted without any resistance because it gave a stronger force compared to the first insertion. In the subsequent insertion process, the catheter was no longer advanced after approximately 3 cm from the skin insertion. It appears that the tip of the puncture

needle penetrates the posterior wall of the SCV and is inserted into the surrounding tissue. Moreover, because the guidewire for children is thin and weak, the distal portion may be amputated during excessive manipulation within the tissue.

Unlike adults, in infants, the diameter of the blood vessel is small, and puncture needle can easily penetrate the wall of the blood vessel even with slight manipulation. Therefore, if blood aspiration has been confirmed during the insertion process, one should carefully insert the induction wire without moving the needle. In addition, if the guidewire is not easily removed and resistance is felt, the state of the guidewire should be checked in radiographic images to avoid over-manipulation. Moreover, although in our case, the residue was placed outside the blood vessel and no other complications occurred, we could not rule out complications, such as bleeding from direct damage to SCV, hematoma, or heart damage. Therefore, we should have cardiothoracic or vascular surgery on standby. Particularly, in premature infants, a long-term central venous catheter is often required, so the practitioner's proficiency is an essential factor for the success of CVC.

Ⅳ. CONCLUSION

In conclusion, CVC using the subclavian vein for the purpose of premature infant care is recommended owing to the technical ease of cannulation without complications depending on the experience.

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