

Clinical Experience of Percutaneous Femoral Venous Catheterization in Critically Ill Preterm Infants Less Than 1,000 Grams

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Background: Venous access is relatively difficult in preterm infants. Central venous catheterization is indicated for pressure monitoring, drug therapy, and nutrition supplementation, which are often critical in the anesthetic management of infants undergoing major surgery.

Methods: In 49 critically ill preterm infants weighing less than 1,000 g, the femoral vein was cannulated using a 22-gauge Angiocath (25 mm; Becton Dickinson, Sandy, UT). A 2.5-ml syringe was attached to the Angiocath, and the Angiocath was advanced with constant negative pressure over the syringe. When blood return was observed, the cannula was advanced. When free blood reflux was achieved, a J wire was inserted, followed by a 24-gauge central venous catheter.

Results: The overall catheterization success rate was 79.6% (39 of 49 attempts). The time required for successful catheterization was less than 10 min in 18 cases (46.2%), 10–20 min in 17 cases (43.6%), and 20–30 min in 4 cases (10.3%). In the successful group, 1 catheter tip was positioned in the vein of the liver (2.6%), 2 were in the common iliac vein (5.1%), 6 were in the right atrium (15.4%), and 30 were in the infracardiac inferior vena cava (76.9%). Complications included hematoma in six cases (12.2%), arterial puncture in five cases (10.2%), bleeding in two cases (4.1%), and transient bradycardia in two cases (4.1%).

Conclusions: The results indicate that percutaneous femoral venous catheterization is a reliable and valuable technique for critically ill preterm infants weighing less than 1,000 g.

VENOUS access is relatively difficult in preterm infants. Central venous catheterization is indicated for pressure monitoring, drug therapy, and nutrition supplementation, which are often critical in the anesthetic management of infants undergoing major surgery.¹ However, central venous catheterization requires much skill and care in pediatric patients. It can be particularly difficult in low-body-weight, critically ill preterm infants.

For anatomical reasons, the internal jugular vein is usually preferred in heavier babies.² However, in extremely low-birth-weight infants (< 1,000 g), percutaneous cannulation of the internal jugular vein can be difficult because of the small size of the vessel and its close proximity to the carotid artery. Complications may occur, such as hematoma,³ Horner syndrome,⁴ pneumothorax,³ and injury of the thoracic duct.⁵ The femoral

vein is one of several alternate sites available for cannulation. There have been few reports regarding central venous catheterization in very-low-birth-weight, critically ill infants. This prospective study was designed to evaluate the success rate of femoral venous catheterization for establishing venous access in very-low-birth-weight, critically ill preterm infants.

Materials and Methods

The study was conducted with approval from the Institutional Review Board of China Medical College Hospital, Taichung, Taiwan, for research on human subjects, and formal consent from parents for the procedure was obtained. The results of 49 central venous catheter placements in preterm infants weighing less than 1,000 g were documented and analyzed. Forty-six catheterizations were performed with the infant in an incubator in the neonatal intensive care unit. Two catheterizations were performed in the open warmer in the neonatal intensive care unit, where elective patent ductus arteriosus ligation was to be performed. One catheterization was performed in the operating room because of emergent laparotomy. Routine monitoring included continuous electrocardiography, pulse oximetry, and apnea alarm monitoring. Midazolam, 0.05–0.1 mg/kg, was administered intravenously or intramuscularly by the pediatrician for sedation before the procedures, except for those three patients prepared for surgery. For those infants, catheterization was performed after administration of general anesthesia. For all patients, a light warmer was used to prevent hypothermia.

For catheterization, a 5-cm-thick pad was placed beneath the infant's buttocks to expose the inguinal area, and an assistant gently held both legs. After appropriate preparation, femoral venipuncture was performed with a 22-gauge Angiocath (25 mm; Becton Dickinson, Sandy, UT) attached to a 2.5-ml syringe to which constant negative pressure was applied. When blood return was observed, the cannula was slightly advanced. After successful aspiration of blood, a guide wire with a J tip was inserted through the cannula. A 24-gauge central venous catheter (Arrow, Reading, PA) measuring 9 cm in length was inserted over the guide wire, and the J wire was removed. The catheter was aspirated to assure free flow, and a dressing was fixed. Routine roentgenographic examination of the kidney, ureter, and bladder was performed to confirm the position of the catheter tip.

The time required to complete the procedure successfully was calculated from the start of venipuncture to the

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end of introduction of the central venous catheter. Hematoma was defined as prominent skin protrusion over the puncture site. Arterial puncture was defined as pulsatile blood flow or bright-red bloody aspiration. Transient bradycardia, as shown on the electrocardiogram, was defined as heart rate below 100 beats/min. The catheterization attempt was discontinued if successful venipuncture was not achieved after more than 30 min.

Results

Forty-nine infants, with an average weight of 755 ± 155 g (mean \pm SD; range, 350–950 g), were scheduled for femoral venous cannulation. Their mean age was 19 ± 11 days (range, 2–40 days). All patients were normothermic. All procedures were performed by the author. Thirty-nine of the 49 attempts were successful (79.6%). Seventeen were on the right side, and 22 were on the left side. The time required to successfully complete the procedure was less than 10 min in 18 cases (46.2%), 10–20 min in 17 cases (43.6%), and 20–30 min in 4 cases (10.3%). Complications included hematoma in six cases (12.2%), arterial puncture in five cases (10.2%), bleeding at the puncture site in two cases (4.1%), and transient bradycardia in two cases (4.1%). There was difficulty in introducing the J tip of the guide wire in two cases (4.1%). Therefore, it was introduced *via* the straight soft tip of the guide wire without complications. In addition, the catheter could not be advanced beyond 5 cm in two cases (4.1%). However, blood return was good and flow was patent.

All 39 patients had kidney, ureter, and bladder examination after the procedure to evaluate tip positioning of the catheter. One was in the vein of the liver (2.6%), 2 were in the common iliac vein (5.1%), 6 were in the right atrium (15.4%), and 30 were in the infracardiac inferior vena cava (76.9%).

Discussion

Central venous catheterization is commonly used for anesthetic management and critical care. From a technical viewpoint, obtaining percutaneous central venous access in infants is difficult, especially in those infants who are critically ill and have low body weight. Internal jugular venous cannulation is more difficult in infants,³ and the subclavian route involves the risk of pneumothorax, hydrothorax, and hemothorax.⁶

Some previous studies have found femoral venous catheterization to be rather safe for infants and children with an expected high success rate and acceptably low complication rates.^{7,8} Other studies reported that central venous catheters in very-low- and low-birth-weight infants are associated with a high incidence of infectious and mechanical complications.^{9,10} In contrast, Venkataraman *et al.*⁷ reported that femoral venous catheteriza-

tions in infants and children are safe, with high success and low complication rates. In the current study, the success rate was high when performed by an experienced anesthesiologist. The immediate complication rate was low, even for very-low-weight, critically ill infants. Long-term complications were beyond the scope of the current study. However, the procedure was life-saving for critically ill infants because fluids or vasopressors could be administered as soon as possible. Getzen *et al.*¹¹ also reported a low morbidity for femoral vein catheterization when compared with subclavian and antecubital vein catheterization. They suggested that this approach be considered when short-term massive intravenous fluid administration is indicated, such as for the treatment of circulatory collapse or cardiac arrest.

Excessive catheter advancement should be avoided in low-birth-weight infants because of the risk of cardiac perforation and fatal pericardial tamponade.^{12,13} The size of the central venous catheter may be critical; from my clinical experience, a catheter larger than 24 gauge leads to difficulty in insertion and to more complications. In addition, insertion of the guide wire involves the potential risk for great vessel or cardiac injuries and should be performed carefully. It is best to mark the guide wire before insertion.

In a study by Kanter *et al.*,¹⁴ femoral venous catheterization in infants was performed with ultrasound guidance. Among the 75 infants, the success rate was 78%, with a 3% rate of arterial puncture. In the current study, femoral venipuncture was performed blindly. The rates of success and arterial puncture were 79.6 and 10.2%, respectively. It should be noted that the age of the current patient group was younger than that of the group of Kanter *et al.*¹⁴ Despite a higher rate of arterial puncture in the current study, it was not associated with serious sequelae because only small hematomas were noted. Therefore, for safety reasons, I recommend using a 22-gauge Angiocath for venipuncture, instead of the puncture needle in the central catheter package. Because the caliber of the smaller 24-gauge Angiocath does not allow guide wire insertion, it was not recommended.

There were two cases of bleeding at the puncture site. In these two cases, there was a low platelet count resulting from sepsis. However, the bleeding stopped after gentle compression. Two patients had transient bradycardia. The possible mechanism may be related to airway and breathing problems because the bradycardia resolved quickly after bagging with pure oxygen.

Difficulty in advancing the guide wire with a J tip and the catheter may have been caused by the small caliber of the vessel, especially for insertion *via* the J-tip end. Therefore, in two cases, insertion of the straight soft tip was chosen. Use of the straight tip involves the risk of vessel trauma and advancement outside the vessel. Although there were no such complications in this study, it is important to keep in mind the possibility of their

occurrence. In addition, the catheter may not be able to be advanced completely because of failure to advance the guide wire. The 24-gauge catheter is small, soft, and difficult to advance without a guide wire.

Conclusion

The high success and low immediate complication rates without serious sequelae suggest that femoral venous catheterization with appropriate indications is suitable for critically ill preterm infants weighing less than 1,000 g.

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