



Using phlebotomy to remove a difficult peripherally inserted central catheter insertion and removal in very low birth weight infants: case report of a rare complication

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Background: A peripherally inserted central catheter (PICC) is an important way to supply long-term intravenous infusion or parenteral nutrition for premature infants, especially very low birth weight (VLBW) infants. PICC removal difficulties occur mostly during use. It is rare to have difficulty removing a PICC due to reverse folding during catheterization. We presented a case to explore the nursing experience of caring for a VLBW infant with difficult PICC removal.

Case Description: A 30-week, 1,240-g infant, suffered a difficult PICC removal during the catheterization adjustment process. The X-ray images showed that the tip of the catheter was bent at the elbow joint and formed three abnormal bends in the blood vessel. The result was that the catheter was removed by a multidisciplinary team, and the reasons for the difficulty were analyzed. We used multidisciplinary team collaboration to solve a clinical problem. First, we analyzed the possible causes of a difficult removal by consulting PICC nurses, vascular interventional surgeons, and venous specialist nurses. Second, we used nonsurgical treatment methods to try to solve the problem. Finally, the catheter was completely removed using phlebotomy. Healing of wound and the growth of blood vessel are both well.

Conclusions: In neonates, PICC may have obstacles in insertion and removal, methods such as posture changes, wet and hot compresses, and local massage can help. Multidisciplinary cooperation can improve the success rate of removal with minimal trauma. Individualized analysis of causes and measures are key steps to solve the difficulty of PICC insertion and removal.

Keywords: Peripherally inserted central catheter (PICC); very low birth weights (VLBW); insertion difficulty; removal difficulty; case report

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Introduction

In premature infants, especially very low birth weight (VLBW) infants, the imperfect development of the gastrointestinal tract makes it difficult to meet their nutritional needs through independent feeding, and

parenteral nutrition is required. A peripherally inserted central catheter (PICC) is an important way to supply long-term intravenous infusion or parenteral nutrition. The most suitable target for applying it in premature infants, especially VLBW premature infants (1). However, PICC



Figure 1 The tip of the catheter was bent at the elbow joint and formed three abnormal bends in the blood vessel.

in infants is a highly technical procedure, and improper operation can cause complications such as catheter blockage, infection, mechanical phlebitis, and even difficulty in removal, which affects efficacy. The incidence of PICC removal difficulty is 0.340–0.965% (2). It has been reported in the literature that PICC removal difficulties occur

mostly during use. It is rare to have difficulty removing a PICC due to reverse folding during catheterization. Baby H, a 30-week, 1,240-g infant, a VLBW premature infant, was admitted to Department of Neonatology of The First Affiliated Hospital of Jinan University, on October 7, 2020. His PICC catheterization process was not smooth; during the catheterization adjustment process, the catheter flexed in the blood vessel, which made it difficult to remove it. After an attempt with the guidewire failed, the vascular interventionalist successfully removed the catheter through a radial vein incision. We present this case in accordance with the CARE reporting checklist (available at <https://acr.amegroups.com/article/view/10.21037/acr-23-145/rc>).

Case presentation

All procedures performed in this study were in accordance with the ethical standards of The First Affiliated Hospital of Jinan University (Guangzhou, China) and with the Helsinki Declaration (as revised in 2013). Written informed consent for publication of this case report and accompanying images was not obtained from the patient's guardians after all possible attempts were made.

Clinical information

Baby H, a 30-week, 1,240-g infant, premature rupture of membranes approximately 10 hours; born by cesarean section, clear amniotic fluid at birth, Apgar score 8-9-9, shortness of breath and inspiratory three-concave sign. The proposed diagnosis is: "(I) premature infant (smaller than gestational age); (II) VLBW infant; and (III) neonatal respiratory distress syndrome".

By day 2 of life, the infant was ready to perform PICC inserter in his left arm, and the length of the catheter planned to be inserted was 15.5 cm. However, after inserting 12.5 cm, the catheter could not be advanced. At this time, a sterile guide wire of the same model produced by the same manufacturer was used to try to help deliver the catheter, but there was still no movement of the catheter. To find the reason, we performed bedside X-rays of the infant. The image showed that the tip of the catheter was bent at the elbow joint and formed three abnormal bends in the blood vessels (*Figure 1*). We applied wet and hot compress and massage to the infant left arm and tried to remove the catheter again. At this time, the catheter moved out 2 cm, and 10.5 cm remained in the blood vessel. X-ray showed that the tip of the catheter remained bent at the elbow joint.

Highlight box

Key findings

- Multidisciplinary team collaboration to solve a difficult peripherally inserted central catheter (PICC) removal can minimize trauma to infant and improve the safety and reliability of PICC removal.
- It is safe and feasible for vascular interventional surgeons to use phlebotomy to remove PICC.

What is known and what is new?

- Difficulties in PICC removal may be related to venous spasm, phlebitis caused by infection, fibrous attachments on the catheter, and biofilm formation of coagulase-negative staphylococci in the catheter.
- Difficulties in PICC removal could also happen during the catheterization adjustment process, for example the tip of the catheter bent at the joint and formed abnormal bends in the blood vessel.

What is the implication, and what should change now?

- Individualized analysis of causes and measures are key steps to solve the difficulty of PICC insertion and removal.



Figure 2 The tip of the catheter remained bent at the elbow joint.

Nursing process

Full assessment

PICC nurses, vascular intervention surgeons, and venous specialist nurses were invited to consult, and we review the literature and notes about the catheterization process and X-ray examination results. We inferred that difficulties in PICC removal may be caused by ectopic flexion of the catheter, abnormal blood vessels in the child or phlebitis. After full discussion by the multi-disciplinary team, first, we can choose non-surgical treatment, and if the catheter cannot be removed, then we will adopt a surgical method.

Affected limb care

The infant was placed on the right side to elevate the left arm. A hydrocolloid dressing was used to properly fix the PICC, and disposable gloves were used to wrap the affected limb to avoid contamination or pulling the catheter. Magnesium sulfate wet and hot compresses, and gentle massage with mucopolysaccharide polysulfate cream were applied along the vessel. If we observe the infant red skin, swollen limb, or oozing fluid, we should avoid infusions, measure blood pressure, and wet the affected limb. And pay attention to protect the catheter to avoid pulling the catheter when we are helping the infant to turn over.

Guidewire to guide removal

The day after the catheter was inserted, under the guidance

of the PICC nurse and the venous treatment specialist nurse, the guidewire was used to assist in the removal. The sterile guidewire of the same model was put into the PICC to use the buffer force of the guidewire to reduce tension on the catheter and release the flex. The guidewire was used with the catheter to slowly pull on the catheter at the same time. After pulling out 2 cm, the catheter no longer moves outward. The guidewire was removed, and the PICC removal was suspended. We used magnesium sulfate for wet and hot compresses to dilate blood vessels. Then the guidewire was inserted again, and the position of the infant arm was continuously adjusted at different angles, but only 1 cm of the guidewire was removed more. We removed the guidewire again and took X-rays. The imaging data showed that the tip of the catheter remained bent at the elbow joint (*Figure 2*).

Assist the doctor with phlebotomy

Five days later, the vascular interventionalist performed a 2 mm phlebotomy to remove all the catheters. We applied pressure to the wound with gauze and bandaged it for 6 hours. Infusion and blood pressure measurements were avoided on the affected limb. The condition of the affected limb was closely observed. An aseptic operation was used to disinfect the wound, and the dressing was changed every day. The wound healed well after the operation, the skin temperature and color of the left arm were normal, and the infant moved freely.

Close observation of changes in the infant condition

The infant vital signs and changes in blood oxygen saturation were closely monitored. If the infant has sudden dyspnea, cough, hematemesis, cyanosis, or shock, the occurrence of deep vein thrombosis is a possibility. The limb circumference at the same position of the affected limb should be measured daily to observe whether there is any occurrence of swelling and to observe the skin color, temperature, sensation in the affected limb, and pulsation of the radial artery. The biochemical indicators and blood gas analysis results of the infant were monitored to observe whether there was a blood infection.

Discussion

PICC has been used in neonatal intravenous nutritional support since 1973 due to its advantages of long indwelling time, less trauma, and low risk (3). It has now become an indispensable and important method for neonatal

parenteral nutrition support, but the surgical procedure or improper care can result in complications. A study has shown that thrombosis is a common and mostly asymptomatic complication in children with a PICC (4) and is often associated with multiple intubations and excessive indwelling time. Difficulties in PICC insertion and removal are relatively rare complications. The main reasons for difficulties in PICC insertion can be divided into physiological and psychological reasons. The physiological reason is mainly the abnormal blood vessels of the patient, and the psychological reason is mainly the vasoconstriction caused by tension during PICC insertion (5). A study has shown that the valve of the blood vessel, the angle between the blood vessels, and the vascular space are the vascular anatomy basis for the formation of PICC insertion difficulties (6). Difficulties in PICC removal may be related to venous spasm, phlebitis caused by infection, fibrous attachments on the catheter, and biofilm formation of coagulase-negative staphylococci in the catheter. The incidence rate is 1–12% (7,8). In 1990, Gladman (9) first reported four cases of PICC with difficulties in removal, two of which used phlebotomy to remove the catheter, and the other two used a splint fixed on the infant arm to perform continuous and stable traction on the catheter. Finally, the catheter was completely removed. Lawrence Miall reported eight cases of cystic fibrosis in children with PICCs made it difficult to remove their catheters (10). Treatment methods were mainly wet and hot compresses, local use of nitroglycerin patches to dilate blood vessels, and nonsurgical traction catheters. In one case, these methods were ineffective. Finally, a special method was adopted to orally administer ibuprofen three times a day, 200 mg/24 h. After systemic treatment, the catheter was removed. After removal, the catheter had fibers and fibrin adhesion. The researcher speculated that the cause might be the grindstone powder in the sterile cotton cloth, surgical drape, and gloves. In another case, the catheter broke during nonsurgical traction and was removed by phlebotomy. Sharpe and Roig (11) reported a case of an ultralow birth weight premature infant born at 29-week with a birth weight of 970-g. After 18 days of PICC treatment, care providers had difficulty removing the catheter. They sedated the infant with midazolam before the operation. After inserting a guidewire, the catheter was completely removed, and there was no adverse reaction after the operation. Van Mechelen (12) reported a case of hypoxic-ischemic encephalopathy in an infant with a birth weight of 2,950-g. When removal of the PICC became difficult,

care providers cut the catheter at the distal end and inserted a guidewire of the same type and size into the PICC. This increased the force of manual traction without causing the catheter to break, and the catheter was removed.

In summary, the difficulties of PICC insertion and removal are relatively rare complications of PICCs, but there are preventive measures and treatments. First, the catheterization process is strictly regulated by the CLB guidelines of the Institute for Health Care Improvement in the United States, and these regulations can effectively reduce the occurrence of catheter-related bloodstream infections in VLBW infants. The regulations address five main measures: hand hygiene, maximum sterility, skin disinfection, selection of the best puncture site, and daily assessment of whether to remove the catheter (13). Second, catheterization can be guided by ultrasound in real time, which has now become a standard practice for PICC insertion, and this can reduce the total number of PICC insertion and significantly reduce the incidence of complications (14). The vein viewer can also increase the success rate of PICC insertion (15). It uses a near-infrared light source to image the hemoglobin in red blood cells and project the image onto the skin through image processing technology. It is a noninvasive method. Finally, we can inject saline while inserting the catheter into the blood vessel. Thus, resistance and violent delivery of the tube are avoided. We can soothe the infant and relieve their tension. We can also use hot compresses to relieve vasospasm or adopt relaxation techniques such as adjusting the position of the limbs and massaging the blood vessels. When there are difficulties in PICC removal, the following methods can be used: massage the blood vessels, change the position of the infant, and use relaxation techniques to expand the blood vessels. Heparin saline was used to flush the catheter to eliminate difficulty in PICC removal due to coagulation. Applying hot, wet compresses at the proximal end of the puncture port or using nitroglycerin patches to dilate blood vessels can reduce venous spasm. After proper fixation, manual traction can be used, but it should be noted that this method risks breaking the catheter. Using a sterile guidewire can help pull the catheter out. After all noninvasive measures are exhausted, phlebotomy can be used to remove the catheter.

Conclusions

In this case, we used multidisciplinary team collaboration to solve a clinical problem. First, we analyzed the possible

causes of a difficult removal by consulting PICC nurses, vascular interventional surgeons, and venous specialist nurses. Second, we used nonsurgical treatment methods to try to solve the problem. Finally, the catheter was completely removed using phlebotomy. These steps can minimize trauma to children and improve the safety and reliability of PICC removal. We believe that the reasons for the difficulties in catheter insertion and removal in this case may have been the individual blood vessels of the infant, vasospasm during the delivery process, and the short delivery of the catheter when the guidewire was used to assist the delivery. Because the reason for the occurrence is quite special and there are no reports of this nature in the literature, analyzing and summarizing the diagnosis and processes in this case can provide valuable experience for PICC insertion and nursing in the future.

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Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at <https://acr.amegroups.com/article/view/10.21037/acr-23-145/rc>

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <https://acr.amegroups.com/article/view/10.21037/acr-23-145/coif>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of The First Affiliated Hospital of Jinan University (Guangzhou, China) and with the Helsinki Declaration (as revised in 2013). Written informed consent for publication of this case report and accompanying images was not obtained from the patient's guardians after all possible attempts were made.

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