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Original Article

Effect of femoral PICC line insertion in neonates with digestive tract disease

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Abstract: Objective: To investigate the clinical effects of various catheterization pathways to guide vein selection in neonates. Methods: In this retrospective study, a total of 40 newborns admitted to the Neonatal Surgery Department of Nanjing Children's Hospital who were hospitalized for gastrointestinal diseases and required intravenous nutrition from March 2020 to December 2020 were included. The patients were divided into a control group (basilic vein and superficial temporal vein) and an observation group (femoral vein of the lower extremity) according to the puncture site of the vein. Blood loss, incidences of phlebitis, incidences of catheter dislocation, frequency of dressing replacement, catheter-related blood infection rate, the satisfaction of family members and bacteriological test results of the catheter tip (1-2 cm) after catheter removal were compared between the two groups. Results: The incidence of phlebitis and catheter dislocation was lower while the satisfaction rate of family members was higher in the observation group as compared with those in the control group (all $P<0.05$). Conclusions: PICC insertion through the femoral vein can effectively reduce catheter-related complications, shorten the days of hospitalization and improve the comfort of children and the satisfaction of their families.

Keywords: PICC, femoral vein, upper limbs vein, complications

Introduction

With the continuous development of transfusion technology, central venous catheter implantation through the peripheral vein has been widely used in many hospitals and achieved considerable progress. Catheterization of a peripherally inserted central catheter (PICC) allows the PICC line to be inserted into a central vein through a peripheral vein running into a deep vein inside the superior or inferior vena cava [1, 2].

PICC is highly safe, with simple operation, few complications and high success rate; all of which reduces the pain caused by repeated punctures. Currently, the superior vena cava is commonly reached throughat the basilic vein, median cubital vein, cephalic vein, axillary vein, superficial temporal vein of the head or the retroauricular vein etc. However, the great saphenous vein, small saphenous vein, popliteal vein and femoral vein of the lower limbs can also be used for catheterization with PICC [3, 4].

The number of low weight and ultra-low weight infants is increasing [5]. Considering their immature digestive system, parenteral nutrition is usually needed. In addition, since the 1970s, PICC has been widely used as a route of parenteral nutrition input for newborns, especially for preterm and low birth weight infants. In this setting, the application of PICC in the Neonatal Intensive Care Unit (NICU) is expanding. Plenty of clinical data has demonstrated that the vascular conditions of infants are delicate, which result in puncture difficulties. In addition, crying and limb activities of infants lead to dislocation of the PICC, and the related mechanical injuries thus increase [6, 7]. The dislocation rate of PICC in upper extremities is significantly higher than that in the femoral vein, and the incidence of phlebitis is also high, resulting in a shorter PICC indwelling time [8]. Traditionally, CRBSI (catheter related blood stream infection) rate with the PICC inserted through the femoral vein is higher due to contamination of the stool and urine. Moreover, infants with gastrointestinal diseases admitted to neonatal surgery may

form venous thrombosis of lower limbs due to abdominal surgery and long-term use of intravenous nutrition. However, studies have shown that the incidence of infection in infants with femoral vein catheterization is not different from that in infants with upper limb vein catheterization or scalp vein catheterization. PICC accessed through the femoral vein of lower limbs in neonates has a shorter operation time, higher one-time puncture success rate, lower incidence of mechanical phlebitis and secondary tube catheterization, longer indwelling time, and lower average heart rate during catheterization and 5 min after catheterization than when accessed through upper limbs [7, 8].

According to the standards of Practice for Infusion Therapy revised in 2016 by the American Society for Intravenous Infusion Nursing, the lower limb veins can also be selected as the route for neonatal PICC placement. A comprehensive understanding of the clinical effects of different neonatal catheterization pathways is beneficial to reducing the incidence of catheter-related complications in infants.

Methods

Participants

In this retrospective analysis, a total of 40 newborns admitted to the Neonatal Surgery Department of Nanjing Children's Hospital who were hospitalized for gastrointestinal diseases and required intravenous nutrition from March 2020 to December 2020 were included (Ethical batch No.202206113-1). Patients were divided into a control group (basilic vein and superficial temporal vein) and an observation group (femoral vein of the lower extremity) according to the puncture site of the vein.

Inclusion and exclusion criteria

Inclusion criteria: (1) neonates with an age of 0-28 days; (2) neonates with digestive diseases (except genetic and chromosomal abnormalities); (3) neonates with TPN (total parenteral nutrition) use >7 days; (4) family members of the infants >20 years old and without history of mental illness; (5) neonates with complete clinical data. Exclusion criteria: (1) neonates with an age of >28 days; (2) neonates with digestive diseases but no need of PICC; (3) neonates with TPN use <7 days.

Preparation of materials for PICC

Nurses with working experience of more than 5 years and those who had obtained PICC catheterization qualification were included in this study. Unified training was conducted in accordance with PICC catheterization operation standard and PICC daily maintenance standard of Nanjing Children's Hospital. Medecon 1.9FrPICC catheter and vascular sheath, 3M central venous catheterization maintenance kit, and 3M antiperspirant dressings were prepared for PICC placement. Then, the same method was used for measurement and X-ray film positioning.

Step of PICC

PICC in the observation group (**Figure 2**): Nurses measured the distance from the 1.9FrPICC catheter puncture point to the femoral vein. The PICC line was inserted through the groin and umbilical region to the xiphoid process. Horizontal measurement was required for infants with abdominal distention. In the process of catheterization, the sterility principle and PICC puncture procedure were strictly followed.

PICC in the control group (**Figure 3**): The 1.9FrPICC catheter was placed in the basilic vein or superficial temporal vein. The distance from the puncture point to the veins of the upper extremities of the right clavicle joint was measured. During the puncture, the arm of neonates was extended to form 90° with the trunk on the puncture side. Superficial temporal vein of the scalp: The PICC line was inserted through the ear to the neck along the vein and turned to the second intercostal space of the right sternoclavicular joint. The remaining steps were the same as those of the observation group.

Observation indices

The blood loss and time of procedure at the time of catheterization were recorded in detail. After successful catheterization, the catheter tip was verified to be within the vena cava by X-ray radiography. The catheter indwelling time, the incidence of phlebitis, the incidence of catheter dislocation, the frequency of catheterization, and CRBSI rate were recorded in detail. After the catheter removal, the catheter tip was clipped 1-2 cm for tip culture, and bacteriologi-

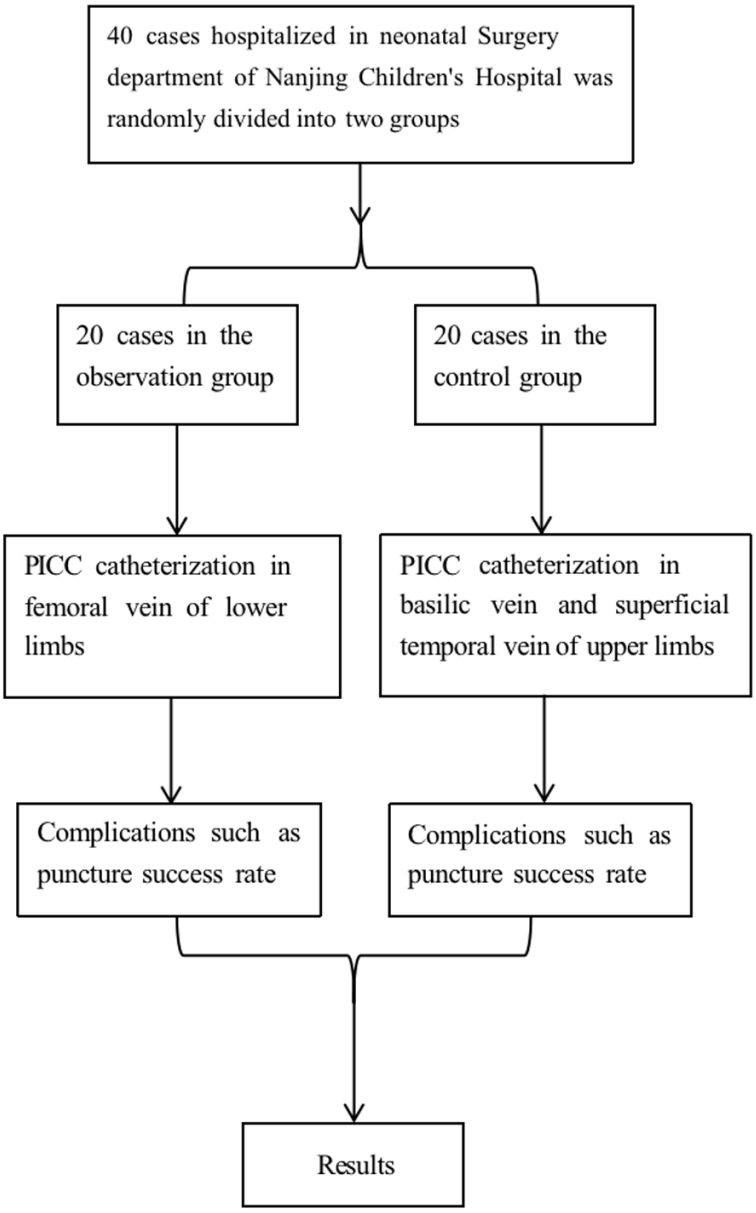

Figure 1. Flow chart.

cal test results were recorded. The satisfaction rate of the parents was surveyed at discharge (There were two options for the parents to choose: satisfied and dissatisfied).

Statistical analysis

SPSS (SPSS Inc., Chicago, USA) was utilized for data analysis. The measurement data conforming to normal distribution was represented as mean ± standard deviation and analyzed using t-test. The count data were express as number (%) and analyzed using Chi-square test. $P<0.05$ indicated statistical difference.

Results

Basic information about infants

The clinical data of 40 patients who underwent PICC catheterization at the Neonatal Surgery Department of Nanjing Children's Hospital from March 2020 to December 2020 were analyzed. The baseline data of the infants, including gender, weight and age, showed no statistical difference between the two groups (**Table 1**), and the enrollment flow chart is shown in **Figure 1**.

Comparison of the incidences of phlebitis between two groups

There were no case of phlebitis in the observation group and 2 cases of phlebitis in the control group; however, the difference was not statistically significant between the two groups (**Table 2**).

Comparison of bleeding amount and bacterial detection rate between the two groups

Due to the thick blood vessels of the lower limbs, the amount of bleeding in the observation group was slightly more than that in the control group. Moreover, the bacterial detection rate in the control group was higher than that in the observation group, but the difference didn't reach statistical significance (both $P>0.05$, **Tables 3**, **4**).

Comparison of dressing change frequency and indwelling time between both groups

Timely diaper change after femoral vein catheterization can effectively avoid urine and stool pollution, and the frequency of dressing re-

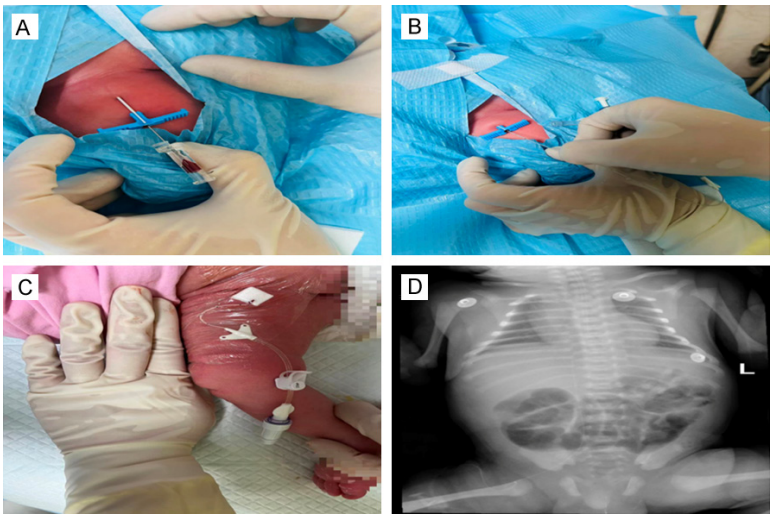

Figure 2. PICC catheterization in the lower extremities of neonates with gastrointestinal disease. A-D: PICC catheterization in neonates with CT test. A: Needle puncture into the selected vein, confirming the sheath is introduced into the vein. B: Tube feeding. C: Fixation. D: Positioning.

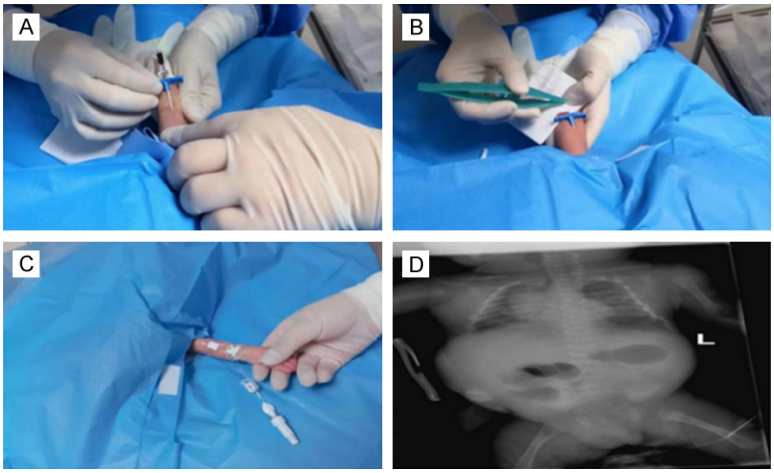

Figure 3. PICC catheterization in upper veins in neonates with gastrointestinal disease. A-D: PICC catheterization in neonates and CT test. A: Needle puncture into the selected vein, confirming the sheath is introduced into the vein. B: Catheter delivery. C: Fixation. D: Positioning.

placement between the two groups showed no significant difference (P>0.05). In contrast with the control group, the indwelling time in the observation group was significantly prolonged (P<0.05, **Table 5**).

Comparison of the incidence of catheter dislocation and family satisfaction between the two groups

The incidence of catheter dislocation was significantly lower in the observation group than that in the control group (P=0.001, **Table 6**). However, there was no statistical difference in the satisfaction rate of family members between two groups (P=0.798, **Table 7**).

Discussion

PICC line placement is a technique in which the tip of the catheter is inserted into a profound vein of the upper limbs or lower limbs. PICC can not only ameliorate the pain from repeated puncture, but also protects venous vessels, downregulates hospitalization costs, and provides patients with a medium- to long-term intravenous treatment [9, 10]. While exerting significant advantages in clinical application, PICC still has some disadvantages. However, suitable PICC access for patients can reduce the incidence of infection, catheter displacement and even catheter prolapse, thus extending the service life of the catheter and improving patient satisfaction. Furthermore, the Center for Disease Control (CDC) and the Practice Guidelines for Central Venous Access suggest to select the most appropriate vein for catheter placement in newborns [11-13].

At present, the field still lacks a refinement of pre-puncture assessment and a unified standard for vein selection in clinical practice, and the number of clinics using femoral vein for PICC access in neonates is limited. Traditional guidelines indicate that the femoral vein should be avoided for PICC catheterization [14, 15]. The characteristics of neonates allow for many sites for PICC vein catheterization [16, 17]. In this study, PICC placement in the femoral vein was compared with its placement in the basilic and head vein to explore the advantages of

Table 1. Comparison of Basic information of infants between the two groups

Basic indexes	Observation group (n=20)	Control group (n=20)	X^2	*p*
Age (d)			0.481	0.829
≥25	8	9		
15-24	10	8		
≤15	2	3		
Sex			0.44	0.741
Male	12	14		
Female	8	6		
Weight (g)			1.051	0.71
≥4500	3	5		
3000-4500	11	8		
≤3000	6	7		

Table 2. The incidences of phlebitis were compared between the two groups

Groups	n	Phlebitis cases	Incidence of phlebitis (%)	X^2	*p*
Observation group	20	0	0	9.75	0.05
Control group	20	2	10		

Table 3. Comparison of amount of bleeding between the two groups

Groups	Bleeding (ml)	*t*	*p*
Observation group	1.895±0.3069	1.868	0.0694
Control group	1.67±0.4426		

Table 4. Comparison of bacterial detection between the two groups

Groups	n	Bacterial detection (cases)	Incidence (%)	X^2	*P*
Observation group	20	0	0	5.308	0.059
Control group	20	1	5		

Table 5. Comparison of the frequency of dressing change and catheterization time between the two groups

Groups	Frequency of dressing change (each week)	Catheterization time (d)
Observation group	6.65±0.2209	30.4±5.062
Control group	6.45±0.1846	25.4±6.082
Chi-square	0.394	-
t value	-	0.4915
p value	0.4915	0.0076

PICC placement through femoral access.

Mechanical phlebitis is one of the most common complications after central venous catheterization [18, 19]. It is mainly caused by repeated friction of venous walls with catheter, unskilled puncture technique, inappropriate puncture site and other factors. Phlebitis is more likely to form a thrombus, which may cause the failure of other organs, especially pulmonary embolism, and this seriously affects the life and health of infants [20-22]. The upper limb vein is longer and narrower than the femoral vein, while the femoral vein is thicker in diameter and deeper in position.

Theoretically, frequent limb movement leads to intimal injury and phlebitis, which is more frequent in the upper limbs than that in the lower limbs. However, the frequency of phlebitis showed no statistical difference between the two groups in this study.

Besides, there was no statistical difference in blood loss between the two groups at the time of implantation. The femoral vein is close to the perineum. Timely diaper change after femoral vein catheterization can effectively avoid urine and stool pollution, thus reducing the frequency of dressing replacement. In this study, there was no statistical difference between the two groups in dressing replacement rate. After the catheter removal, the catheter tip was cut off about 1-2 cm for bacteriological test [23, 24], and the results showed that there was no significant difference in bacterial infection rate between the two groups, which is probably due to the unified training in aseptic operation for nurses. According to the anatomical characteristics of the femoral vein, such as clear structure, thick diameter, and no important surrounding tissues, the operation time in PICC placement in the femoral vein was reduced [25, 26]. Moreover, the insertion point of PICC in the femoral vein is located at the root of the thigh, and leg movement has little effect on the catheter indwelling. In this study, compared with

Table 6. The incidence of catheter dislocation was compared between the two groups

Groups	n	Number of dislocations	Incidence (%)	X^2	*p*
Observation group	20	0	0	13.737	0.001
Control group	20	3	15		

Table 7. The family satisfaction rate was compared between the two groups

Groups	n	Family satisfaction	Satisfaction rate (%)	X^2	*p*
Observation group	20	19	95	0.467	0.798
Control group	20	15	75		

the control group, the incidence of catheter dislocation in the observation group was lower, and the indwelling time was prolonged.

Conclusions

For neonates with digestive disease, PICC accessed through the femoral vein can improve the success rate of catheterization, shorten the operation time of PICC insertion, and reduce the related complications and increase the PICC indwelling time. Suitable access for PICC placement in neonates should be explored in pediatric nursing practice in relevant medical institutions across the country.

Disclosure of conflict of interest

None.

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