Initial peripherally inserted central catheter tip position in neonates*

LOCALIZAÇÃO INICIAL DA PONTA DE CATETER CENTRAL DE INSERÇÃO PERIFÉRICA (PICC) EM RECÉM-NASCIDOS

LOCALIZACIÓN INICIAL DE LA PUNTA DEL CATÉTER CENTRAL DE INSERCIÓN PERIFÉRICA (PICC) EN RECIÉN NACIDOS

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ABSTRACT

This is a cross-sectional study aiming to identify the initial tip position of peripherally inserted central catheters (PICC) and to verify the prevalence of success in inserting such catheters in neonates. The study was carried out in the neonatal care unit of Hospital das Clínicas, Universidade de São Paulo. Data were collected prospectively from March to September 2006. 37 neonates underwent PICC insertion were included in the study. The rate of success for this procedure was 72.3% (27 neonates). Of them, four (14.8%) had the catheter tips placed in the axilary or inominate veins. Three others (11.1%) had them placed in a jugular vein. When these catheters were removed, 13 (48.2%) catheter tip were placed in the right atrium, and they were relocated to the superior vena cava.

KEY WORDS

Catheterization, peripheral.
Venae cavae.
Infant, newborn.
Infant, premature.

RESUMO

Estudo transversal com coleta prospectiva de dados, que objetivou identificar o posicionamento inicial da ponta do cateter central de inserção periférica (PICC) e verificar a prevalência de sucesso de sua inserção em neonatos. Os dados foram coletados no berçário anexo à maternidade do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, entre março e setembro de 2006. Dos 37 neonatos submetidos à inserção do cateter PICC, a taxa de sucesso no procedimento foi de 72,3% (27 neonatos); destes, quatro (14,8%) estavam com as pontas dos cateteres alojadas nas veias axilar ou inominada; outros três (11,1%), alojadas em veia jugular. Estes cateteres foram removidos por desvio de trajeto. 13 (48,2%) estavam com as pontas alojadas em átrio direito, cujos cateteres foram tracionados para reposicionamento da ponta para a veia cava superior.

DESCRITORES

Cateterismo periférico.
Veias cavas.
Recém-nascido.
Prematuro.

RESUMEN

Estudio transversal con recolección prospectiva de datos. La finalidad fue identificar la posición inicial de la punta del catéter central de inserción periférica (PICC) y verificar la prevalencia de éxitos durante su introducción en neonatos. Los datos fueron recolectados en un servicio de neonatología anexo a la maternidad del Hospital de las Clínicas de la Facultad de Medicina de la Universidad de São Paulo, entre marzo y setiembre del 2006. De los 37 neonatos sometidos a introducción del catéter PICC, la tasa de éxito fue de 72.3% (27 neonatos), de ellos, cuatro (14.8%) estaban con las puntas de los catéteres alojadas en las venas axilar o no determinada, tres (11.1%) localizadas en la vena yugular. Siendo estos últimos retirados por desviación en su trayecto. El 48.2% (13) se encontraba con las puntas en el atrio derecho, siendo estos catéteres nuevamente posicionados en la vena cava superior.

DESCRIPTORES

Cateterismo periférico.
Venas cavas.
Recién nacido.
Prematuro.

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INTRODUCTION

Peripherally inserted central catheters (PICC) have been increasingly used in care delivery to critical patients at neonatal intensive care units (NICU), particularly to preterm newborns with very low weight[1-3].

PICC allows for the maintenance of a venous access for long periods and the safe infusion of medication, hypertonic solutions and total parenteral nutrition (TPN) in central veins[4-5].

PICC catheters are more commonly used in intensive care units, with nurses as the professionals in charge of their insertion. Therefore, the nurses have increasingly sought qualification to perform this action.

In Brazil, the attribution of the nurse's technical and legal competence to perform the manipulation of the PICC catheter was defined in Resolution 258/2001 of the Federal Nursing Council.

The growth and expansion of the nursing area is necessary and desirable[6]. However, the incorporation of new procedures into professional practice should be monitored, so that possible complications stemming from this practice can be identified.

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In addition to the several benefits attributed to using PICC catheters, professionals need to be aware of the risks involved in the use of this device, which is associated with some complications that can occur during insertion, while the catheter moves the venous pathway, during maintenance and removal. These complications occur due to mechanical problems like: obstruction, catheter rupture, punctured vessels, overflowing, thrombosis, hydrothorax, among others, and also infectious problems, especially systemic sepsis related to the PICC catheter[1,5].

A successful insertion of the PICC happens when the tip of the catheter is positioned centrally, i.e. in the superior vena cava. If the tip moves beyond the superior vena cava, traction maneuvers will be applied in the catheter for its relocation[7].

Centrally-placed catheter tips are associated with low complication rates when compared to non-central catheters[2]. Therefore, the maintenance of the catheter tip in a central position is extremely important, in order to reduce the risk of complications due to the use of this device.

The PICC catheter has been widely used for administering parenteral nutrition and antibiotics; however, when the tip is not placed centrally, some complications can occur, such as thrombophlebitis, phlebitis and occlusions[8].

The migration of the PICC catheter tip is a common problem and known among neonatologists, and may lead to a lethal situation of pericardial effusion and tamponade following myocardial puncturing. Catheter tips placed in the right atrium, or their migration into the right atrium, are appointed as the probable causes of these complications[9].

Knowing the exact initial location of the PICC catheter tip, after its insertion, is a safety measure recommended to professionals handling PICC catheters.

The success rate of the correct initial placement of the PICC catheter tip is the key to determine the need for other maneuvers for catheter placement. The lower the success rates for the correct initial placement of the catheter tip, the higher the frequency of manipulation will be.

Therefore, each service needs to monitor its own success rate for the placement of the PICC catheter tip, in order to detect causal and intervenient factors of failures and implement measures to improve the success rates of this procedure.

OBJECTIVES

- Identify the initial position of the peripherally inserted central catheter tip;
- Verify the prevalence of success in the insertion of the peripherally inserted central catheter.

METHOD

Study design

Cross-sectional study with prospective data collection about nursing practices in the procedure of inserting the peripherally inserted central catheter in newborns hospitalized at a Neonatal Intensive Care Unit.

Study place

The research was developed at the Nursery of Hospital das Clínicas, Faculty of Medicine, University of São Paulo. It has a staff of 17 nurses – seven of which are certified for the procedure of installing PICC catheters granted by the Brazilian Society of Intensive Care *(Sociedade Brasileira de Terapia Intensiva-SOBETI)*. The decision of inserting the PICC catheter is made by the team delivering care to the newborn. Before the catheter insertion procedure is executed, the physician in charge and the nurse check the newborn's laboratory results and assess the risks and benefits of submitting him to the procedure at that moment. The stages of the insertion, maintenance and removal procedures of the PICC catheter follow the recommendations adopted by the course offered by the Brazilian Society of Intensive Care Nurses.

Population

All PICC catheter implantation procedures performed by nurses from March to September, 2006, were included in the study. The inclusion criteria were: having consent from the newborn's parents submitted to the PICC catheter insertion procedure to use information from the newborn's medical records and consent of the nurses installing PICC catheters to participate in the study.

Study Variable

The variables related to the characterization of the population of newborns (gestational age at birth; weight on the PICC insertion date; gender; clinical diagnosis; parenteral therapy instituted through the PICC catheter) and variables related to the catheter insertion (type of material, caliber, initial placement of the catheter tip, success in the procedure of installing the PICC).

Data collection instrument

The collected data were registered on a printed form containing two parts: data on the identification and characteristics of the newborn and data about the PICC catheter insertion procedure.

Data collection Procedure

Data were obtained by consulting the newborns' medical records and observing the procedure of catheter insertion performed by nurses. Before the procedure was started, the newborn's parents or guardians were asked for consent, as well as the nurse responsible for the insertion of the PICC catheter in the newborn. According to Resolution 196/96 of the National Health Council, an organ that regulates guidelines and regulatory standards for research involving human beings in Brazil, the research project, with the respective terms of consent (for the guardians of the newborn and for the nurses) were submitted to the analysis and approval of the Ethics Committee at Hospital das Clínicas at Faculty of Medicine at University of São Paulo (HCFMUSP), registered at the National Commission of Research Ethics (*Comissão Nacional de Ética em Pesquisa - CONEP)* - Protocol n. 00526200604 - 02/24/2006. Data collection started once the project had been approved by the Ethics Committee.

Data organization, treatment and analysis

Data were stored in a Microsoft Excel spreadsheet and transferred to Epi-Info software v. 3.3.2 for processing. For the quantitative variables, the averages, medians, maximum and minimum values and standard deviations were calculated. The data were grouped according to absolute and relative frequency and presented in Tables.

RESULTS

As for the characterization of the newborns submitted to the PICC catheter insertion procedure (Tables 1 and 2), it is verified that male newborns were predominant, born with up to 32 gestational weeks (average of 31.6 weeks), weighing 1,500 grams or less (average weight 1,289 grams) and the catheter was inserted in the first week of the newborn's life for the infusion of total parenteral nutrition.

Table 1 - Characterization of the newborns submitted to the PICC catheter insertion procedure, HCFMUSP Nursery - São Paulo - 2006

VARIABLES	N=37	%
Gender		
Male	22	59.4
Female	15	40.6
Gestational age at birth		
≤ 32 weeks	23	62.2
> 32 weeks	14	37.8
Age on the procedure date		
One to three days	18	48.7
Four to seven days	14	37.8
Eight to eleven days	3	8.1
Twelve to fifteen days	2	5.4
Weight on the PICC insertion date		
≤ 1500g	27	72.3
>1500g	10	27.7
Diagnosis		
Respiratory distress syndrome	21	56.8
Wet lung syndrome	11	29.7
Congenital cardiopathy	2	5.4
Necrotizing enterocolitis	2	5.4
Meconial aspiration syndrome	1	2.7
Indication for PICC catheter usage		
Total Parenteral Nutrition Infusion	35	94.6
Infusion of Prostaglandin E1	2	5.4

Table 2 - Descriptive measurements of the variables characterizing newborns submitted to PICC implantation, HCFMUSP Nursery - São Paulo - 2006

Variable	Average	Median	Mode	Maximum value	Minimum value	Standard deviation
Gestational age at birth	31.6	31.4	27.8	39.8	25.8	3.6
Weight in grams	1.289.2	1.200.0	1.040.0	2.570.0	525.0	541.5
Chronologic age in days	4.3	4.0	2.0	15.0	1.0	3.1

Regarding the type of the PICC catheter material, the more rigid polyurethane catheters were used in 35 (94.6%) newborns, while the softer silicon catheters were used in only two (5.4%) of the newborns.

All catheters had a 2 French caliber, with lengths varying from 48 to 50 centimeters.

Of the 37 newborns submitted to the procedure of PICC catheter installation, the catheter was successfully inserted in 72.3% (27 newborns). In 20.7% (ten newborns), the process resulted in failure related to venous puncturing, the non-progression of the catheter or other reasons.

Before the insertion of the PICC catheter, its length is measured, considering the superior vena cava as the place of insertion. However, during the catheter insertion procedure, the tip can progress towards an unplanned place, being misplaced into another venous branching or even in a place behind or beyond what was planned. Table 3 shows the initial positioning of the PICC catheter tip identified through radiographic images.

Table 3 – Initial position of the PICC catheter tip, HCFMUSP nursery - São Paulo - 2006

Initial position of the PICC catheter tip	N	%
Non-central		
Right atrium	13	48.2
Axillary vein or innominate vein	4	14.8
Jugular vein	3	11.1
Central		
Superior vena cava	7	25.9
Total	27	100.0

Data in Table 3 show that the catheter tips were placed in the superior vena cava for only seven (25.9%) newborns. Of the 27 inserted catheters, four (14.8%) had their tips in peripheral regions, i.e., placed in axillary or innominate veins; three others (11.1%) had their tips placed in jugular veins and were removed by pathway deviation. It should be noted that radiologic images showed that the catheter tips were placed in the right atrium in 13 (48.2%) newborns, which leads to the conclusion that the measurement of the catheter length from the place of insertion into the superior vena cava had been overestimated, since the tip went beyond the superior vena cava and was placed into the right atrium, needing traction maneuvers to relocate it to the correct position. Table 4 presents data about the placement of catheter tips in newborns subject to traction.

Table 4 – PICC catheter tip location after traction maneuver, HCFMUSP Nursery, São Paulo - 2006

Post-traction catheter tip location	N	%
Lower third of vena cava superior	9	69.2
Middle third of vena cava superior	3	23.1
Upper third of vena cava superior	1	7.7
Total	13	100.0

Out of 27 catheters inserted, 24 were fixated with their tips placed centrally or peripherally, as shown in Table 5:

Table 5 - PICC catheter tip location at the moment of fixation, HCFMUSP Nursery, São Paulo - 2006

PICC catheter tip location at fixation	N	%
Central	20	83.3
Midline	3	12.5
Midclavicular	1	4.2
Total	24	100.0

Data in Table 5 show that the tips were centrally relocated and fixated in the superior vena cava in the catheters submitted to traction maneuvers.

It is observed that the prevalence of central catheters was 83.3%, while 16.7% were kept in peripheral locations.

DISCUSSION

According to the characterization data of the population, newborns submitted to PICC catheter insertion are mostly low-weight preterms who need this device to assure their growth and development, since the organs related to suction and nutrition are not fully developed yet.

Prematurity is one of the main causes of hospitalization in neonatal units, accountable for high rates of morbidity and death in the perinatal period[10].

Having central vascular access in newborns hospitalized in neonatal intensive care units, especially preterm newborns requiring parenteral feeding for long hospitalization periods, is a fundamental measure for the survival and recovery of these neonates[1].

A prospective cohort study verified the incidence and location of the PICC catheter tip in newborns admitted at the Neonatal Intensive Care Unit (NICU) in a hospital in Saudi Arabia from 2002 to 2004. The average gestational age of the newborns in that population was 27.7 weeks, and average weight was 1,040 grams. Average age of the neonate at the date of catheter insertion was 12.6 days[3]. The profiles of the newborns submitted to PICC catheter insertion are similar, with a predominance of low-weight preterm newborns.

The clinical diagnosis prevailing in newborns submitted to PICC was the Respiratory Distress Syndrome (RDS), or hyaline membrane disease (HMD), with 56.8% (Table 1). RDS affects mostly premature neonates, weighing between 501 and 1,500 grams. Prematurity, male gender and perinatal asphyxia are risk factors for RDS[11].

A retrospective study comparing different types of percutaneous catheter (polyurethane, silicon, polyethylene and Teflon) to identify the best material for usage in neonatal units verified that polyethylene and Teflon catheters have similar characteristics, but higher incidence of vena

cava thrombosis compared to polyurethane and silicon; higher incidence of thrombophlebitis in the group of newborns using silicon catheters than polyurethane catheters; lower resistance of silicon catheters when compared to the polyurethane catheters, which in turn present higher frequency of fractures; higher bacteremia rates in Teflon and polyethylene catheters. Through the study, advantages and disadvantages were seen in each type of catheter[12]. These data corroborate those of the present study, which identified the usage of both polyurethane and silicon catheters, with a predominance of the former, due to its lower cost than silicon catheters. However, it should be noted that a 20.7% failure rate in the insertion procedure leads to questioning on whether the type of catheter material could be related to successful insertions of the PICC catheter or not.

Reasons for failure of PICC catheter insertion punctures are related to the newborn, directly and indirectly. Factors related to the neonate's anatomy and physiology are considered direct causes, and indirect causes are those related to the skill of the nurse performing the procedure.

The confirmation of the catheter tip location can be visualized through injections of radiopaque contrast, thoracic radiography and ultrasound[13].

One study found success rates for the PICC catheter implantation of 84% when 41 PICC catheter insertion procedures were evaluated prospectively in newborns admitted at a neonatal ICU[3].

When the catheter tip is not placed correctly, it can entail serious complications. One is the cardiac arrhythmia that results when the catheter is below the right atrium or below the right ventricle[14].

The risk of thrombi formation and phlebitis increases when the catheter tip is at the entrance of the superior vena cava[15]

Of the newborns whose catheters received traction, nine (69.2%) had their tips relocated to the lower third of superior vena cava and four (30.8%) were in the middle and upper thirds of the vena cava (Table 4).

One study about the location of the PICC catheter tip found frequencies varying from 25% to 40% in the location of the PICC catheter tip during venous puncture attempts. The tips placed in axillary, subclavian and innominate veins presented a 60%-chance of thrombosis, and 21% for the superior vena cava[16].

The length of the PICC catheter to be inserted depends on the chosen vein and limb, from 10 to 15 centimeters on the average[17].

The nurse is responsible for assisting all patients with PICC catheters. This includes checking the placement of the catheter tip according to thoracic radiography[18].

CONCLUSION

Overall, newborns submitted to PICC catheter insertion were male, with gestational age = 32 weeks at birth, weight lower than 1,500 grams, submitted to the PICC catheter insertion procedure in their first week of life, indicating infusion of total parenteral nutrition. The prevalence of success in catheter implantation was 64.9%, and the catheter tip was placed centrally in 54.1% of the procedures, which is below the findings in literature. Incorrect initial placement of the catheter tip was related to the introduction of catheter length above the necessary, which led the nurses to perform extraction maneuvers to relocate the tip. This data points to the need to review the techniques used to measure catheter length. Another point worth noting is the need for new studies, comparing the success rates of polyurethane catheter insertion with silicon catheters, since the success prevalence rate in the catheter insertion found in this study was lower than those in literature. Studies using silicon catheters are predominant in literature, while the use of polyurethane catheters was predominant in this study.

REFERENCES

1. Sastre JBL, Colomer BF, Cotallo GDC, Aparício AR. Estudio prospectivo sobre catéteres epicutáneos en neonatos. An Esp Pediatr. 2000;53(2):138-47.

2. Racadio JM, Doellman DA, Johnson ND, Bean JA, Jacobs BR. Pediatric peripherally inserted central catheters: complication rates related to catheter tip location. Pediatrics. 2001;107(2):E28.

3. Tawil KA, Eldemerdash A, Hathlol KA, Laimoun BA. Peripherally inserted central venous catheters in newborn infants: malpositioning and spontaneous correction of catheter tips. Am J Perinatol. 2006;23(1):37-40.

4. Chlebicki MP, Teo EK. Review of peripherally inserted central catheters in the Singapore acute-care hospital. Singapore Med J. 2003;44(10):531-5.

5. Camara D. Minimizing risks associated with peripherally inserted central catheter in the NICU. Am J Mater Child Nurs. 2001; 26(1):17-21.

6. Toma E. Avaliação do uso do PICC – Cateter Central de Inserção Periférica – em recém-nascidos [tese]. São Paulo: Escola de Enfermagem, Universidade de São Paulo; 2004.

7. Fricke BL, Racadio JM, Duckworth T, Donnelly LF, Tamer RM, Johnson ND. Placement of peripherally inserted central catheters without fluoroscopy in children: initial catheter tip position. Radiology. 2005;234(3):887-92.

8. Chemaly RF, Parres JB, Rehm SJ, Adal KA, Lisgaris MV, Katz-Scott DS, et al. Venous thrombosis associated with peripherally inserted central catheters: a retrospective analysis of the Cleveland Clinic experience. Clin Infect Dis. 2002;34(9):1179-83.

9. Nadroo AM, Glass RB, Lin J, Green RS, Holzman IR. Changes in upper extremity position cause migration of peripherally inserted central catheters in neonates. Pediatrics. 2002;110(1):131-6.

10. Gaíva MAM, Gomes MMF. Cuidando do neonato: uma abordagem de enfermagem. Goiânia: AB; 2003. O prematuro; p. 35-41.

12. Evans M, Lentsch D. Percutaneously inserted polyurethane central catheters in the NICU: one unit's experience. Neonatal Netw. 1999;18(6):37-46.

13. Kaye R, Sane SS, Towbin RB. Pediatric intervention: an update - part II. J Vasc Interv Radiol. 2000;11(7):807-22.

14. Geddes LAB, Nichols HA. An overview of peripherally inserted central catheters. Adv Pract Nurs J. 2005;5(3):1-9

15. Vesely TM. Central venous catheter tip position: a continuing controversy. J Vasc Interven Radiol. 2003;14(5):527-34.

16. Galloway S, Bodenham A. Long-term central venous access. Br J Anaesth. 2004;92(5):722-34.

17. Pérez EEUM, Faunes M, Avaca M, Torres V, Galleguillos J, Solis L, et al. Uso de cateter central insertado periféricamente por via percutánea em recién nacido. Pediatr Día. 2002;18(1):27-31.

18. Fong NI, Holtzman SR, Bettmann MA, Bettis SJ. Peripherally inserted central catheters: outcome as a function of the operator. J Vasc Interv Radiol. 2001;12(6):723-9.

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