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Original Article

Progression of peripherally inserted central catheter in hemiclavicular region of newborns*

Progressão do cateter central de inserção periférica em região hemiclavicular de recém-nascidos

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ABSTRACT

Objective: to evaluate the progression of the peripherally inserted central catheter in the right hemiclavicular region, through the right basilic and cephalic vein, in newborns. **Methods:** quasi-experimental research, carried out in a neonatal unit. Sample of 64 catheter insertions in 58 newborns. The intervention consisted of shoulder elevation, protraction and lowering maneuver, applied after the catheter had not progressed, in the hemiclavicular region by direct puncture in the cubital region, in the right basilic or cephalic vein. **Results:** of the 64 insertions, 28(43.7%) progressed without maneuver; in more than half, a maneuver was applied, obtaining 28(77.8%) progressions, with 15(41.7%) progressing after elevation, 12(57.1%) after protraction, 1(11.1%) lowering the shoulder, of those that progressed, 21(75%) were in central position. There was statistical significance ($p<0.05$) between progression with maneuver and cephalic vein, progression without maneuver and basilic vein. **Conclusion:** the intervention facilitated the progression of the catheter, mainly through the cephalic vein.

Descriptors: Catheterization, Central Venous; Catheterization, Peripheral; Infant, Newborn; Infusions, Intravenous; Neonatal Nursing.

RESUMO

Objetivo: avaliar a progressão do cateter central de inserção periférica em região hemiclavicular direita, através da veia basílica e cefálica direita, em recém-nascidos. **Métodos**: pesquisa quase experimental, realizada em unidade neonatal. Amostra de 64 inserções de cateteres, em 58 recém-nascidos. A intervenção consistiu em manobra de elevação, protração e abaixamento do ombro, aplicada após não progressão do cateter, em região hemiclavicular, na punção direta em região cubital, em veia basílica ou cefálica direita. **Resultados:** das 64 inserções, progrediram sem manobra 28(43,7%); em mais da metade, aplicou-se manobra, obtendo-se 28(77,8%) progressões, sendo que 15(41,7%) progrediram após elevação, 12(57,1%) após protração e 1(11,1%) abaixamento do ombro, destes que progrediram, 21(75%) estavam em posição central. Verificou-se significância estatística ($p<0,05$) entre progressão com manobra e veia cefálica, progressão sem manobra e veia basílica. **Conclusão:** a intervenção facilitou progressão do cateter, principalmente por veia cefálica.

Descritores: Cateterismo Venoso Central; Cateterismo Periférico; Recém-Nascido; Infusões Intravenosas; Enfermagem Neonatal.

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Introduction

Peripherally Inserted Central Catheter (PICC) is a less invasive device when compared to a catheter inserted by central venous puncture, which can be introduced through peripheral veins of the scalp (temporal and posterior auricular), lower limbs (saphenous vein) and upper limbs (basilic, cephalic and axillary) in newborns[1].

The insertion of PICC in neonatology can be done through direct puncture or modified Seldinger technique and ultrasound[2]. During the practice of catheter insertion, it is observed, in some cases, non-progression through the basilic and cephalic veins, which may be associated with stenosis, tortuous veins, venous spasm, bifurcations and closed venous valves, thrombosis, hematomas, disproportionate caliber between vessel and catheter[3].

In order to overcome the difficulty in progressing the PICC through the vein, it is suggested to infuse saline in bolus, gentle massage in the vein in the direction of the blood flow, warm compress, promoting dilation, repositioning and/or rotation of the limb[4], however, to date, the literature does not report details of this rotation, nor how much it facilitates the progression of the catheter to the superior vena cava.

However, there is no progression in the right hemiclavicular region, close to the shoulder, by catheterization of the basilic and cephalic veins in newborns, which may be related to the 90° angulation of the cephalic vein implantation in the axillary vein, when penetrating the clavipectoral fascia, passing under the clavicle[3] and possibility of compression of the subclavian vein by the clavicle and first rib, at the narrowed costoclavicular angle, being obstacles to progression, as occurs in the Pinch-off Syndrome[5]. Poor progression of the catheter can promote false trajectory and inadequate positioning and this, in turn, is associated with vessel occlusion, with migration and occlusion of the catheter being the most common complications with PICC in neonates[6]. Therefore, the need to create a maneuver that could favor the progression of the PICC in the right hemiclavicular region was recognized.

The shoulder movement maneuver for PICC progression in newborns, studied in this article, was created by the first two authors, it is described in three steps, to increase the subclavian space between first rib and clavicle, decreasing compression, favoring progression , as follows: elevation of the shoulder (applying light pressure to the axillary region, in the podocephalic direction); protraction of the shoulder (slight pressure in the scapular region in the posteroanterior direction, with displacement of the shoulder forward); lowering of the shoulder (applying light pressure on the newborn's shoulder, displacing it downward, in the cephalopodal direction, with displacement of the shoulder downward).

Good innovative practices in nursing care in the insertion of PICC in newborns favor success in insertion, mitigating failure in insertions, loss of catheter and unnecessary exposure of the newborn to longer procedure times, repeated venipuncture and risk of inappropriate positioning.

With that, we investigated the progression of the PICC, in the right hemiclavicular region, by insertion in the basilic or right cephalic vein of the cubital region of newborns, with and without the application of the maneuver. The objective was to evaluate the progression of the peripherally inserted central catheter in the right hemiclavicular region, through the right basilic and cephalic vein, in newborns.

Methods

Quasi-experimental research, with pre- and post-test design in a single group, which consists of applying a pre-test (prior to intervention - maneuver); intervention (maneuver); and post-test (post-intervention - post-maneuver), developed in a conventional intermediate care unit and a neonatal intensive care unit at a maternity school, from tertiary care to the mother-child binomial, in Ceará, Brazil.

The explanatory variable is insertion of the

PICC into the right basilic or cephalic vein, punctured in the cubital region, which has progressed or not, in the right hemiclavicular region of newborns. The expected outcome, in cases where the PICC does not progress, is its progression in the right hemiclavicular region after application of the maneuver and tip of the catheter in central position.

The temporal sample consisted of 64 PICC insertions (inserted by direct puncture, without the aid of ultrasound), in 58 newborns who met the inclusion criteria, between January and April 2014, by four skilled nurses from the units, qualified, experienced and trained in the research method, the institution's standard operating procedure and catheter insertion. At each procedure, a pair of nurses participated in the insertion of the PICC.

Newborns with PICC indication for infusion of antibiotics, parenteral nutrition, vasoactive drugs, at any gestational age and birth weight were included. Those with congenital malformations, fractures, upper limb and/or clavicle dislocations, bruises in the brachial path of the right basilic and cephalic veins were excluded, as well as failure to perform chest X-ray or six hours after PICC insertion.

The data collection instrument consisted of neonatal and perinatal variables, such as sex, birth weight, gestational age (birth) and chronological, medical diagnosis of hospitalization, indication for catheter implantation, choice of the vein by randomization or single punctureable vein, catheterized vein, PICC progression, in the right hemiclavicular region, before and after each step of the maneuver, and time elapsed from insertion and chest X-ray.

The pre and post-tests, necessary for the quasi-experimental study, were characterized by measuring the progression of the catheter before and after the maneuver as follows: with shoulder abducted at 90° and elbow extended, the distance between cubital regions and right hemiclavicular region is measured in centimeters (pre-test measurement), using a measuring tape placed at the catheter insertion point up to the hemiclavicular point, also measured using the measuring tape; the catheter is inserted up to the right hemiclavicular region (obstacle), the maneuver is applied and another three centimeters of the catheter are inserted (post-test measurement), this being the distance to the third intercostal space (cavoatrial junction) in a newborn.

For insertion of newborns, the inclusion criteria were respected, after signing the Free and Informed Consent Form by parents and/or guardian. After the decision to insert the PICC (made of polyurethane, mono-lumen, 1.9 *French*), the pair of trained nurses carried out the evaluation of the right cubital region, aiming to observe the venous network and the presence of lesions in this area. From this, it was decided to choose the puncture vein. In this research, the visible and or palpable vein was defined as the punctureable vein, free from obstacles to puncture, such as stenosis, the presence of previous lesions such as bruises and phlebitis, as they make the puncture difficult, and may cause injuries to the newborn.

Thus, when the right basilic and cephalic veins were punctureable, the nurses responsible for the collection drew in which vein the procedure started or when there was only one punctureable vein (basilic or right cephalic), the one that was available was chosen. This procedure was performed after the newborn was selected for research and before the procedure started.

When starting the procedure, the two nurses decided who would puncture the vein and insert the PICC. After venipuncture, two results were obtained: success or failure. As the first puncture was successful, the catheter was inserted up to the measurement corresponding to the third right intercostal space. If unsuccessful, if there is another punctureable vein, the second puncture was performed, introducing the catheter up to the third right intercostal space, if not, the collection was ended.

With a successful puncture, the catheter was inserted until into the right hemiclavicular region. With progression in this region, the catheter was introduced until the cavoatrial junction and the collec-

tion was ended; without progression through the right hemiclavicular region, the maneuver was applied. When performing the maneuver, two results were obtained, progression or non-progression, after the first, second or third step of the maneuver applied to the newborn's shoulder. With progression, the position of the catheter was assessed by chest radiography. If central positioning, the result of the maneuver was defined as totally successful, in the case of peripheral positioning, it was defined as partially successful maneuver, that is, it progressed, and however, it positioned itself peripherally.

It is noteworthy that the verification of the positioning of the catheter tip was done by means of chest radiography performed up to six hours after the end of the procedure. If any mishap occurred and the radiograph was not performed, the insertion would be excluded from the research, as it is known about the possibility of spontaneous repositioning of the catheter, post-insertion[7]. However, there was no exclusion of insertions, for this reason, during the research.

The data were compiled in the Excel version Microsoft Office Excel 2010, processed and analyzed using the Statistical Package for the Social Sciences 20.0 program. To investigate whether the progression of the catheter depended on the type of vein, Pearson's Chi-Square Test was first considered. However, due to the high number of expected frequencies lower than five (more than 25.0% of the cells), Fisher's Exact Test was used for the same purpose. The contribution of each maneuver to change the catheter's reach was assessed with the aid of the McNemar Test. For a possible relationship between the location of the tip of the PICC and the moment when the catheter progressed, Pearson's Chi-Square Test was used.

The research was approved by the institution's Ethics and Research Committee, according to the opinion nº 408,041 and Certificate of Presentation for Ethical Appreciation nº 22225113,5,0000,5050, and the national and international research norms involving human beings were respected.

Results

58 newborns participated in the research who met the inclusion criteria, of which 53 (91.4%), 4 (6.9%) and 1 (1.7%) were submitted to one, two and three insertions, respectively, totaling a sample of 64 PICC inserted. Of the 64 (100.0%) insertions, 36 (56.25%) did not progress and the newborns were submitted to the maneuver.

There was a predominance of females, 30 (51.7%), birth weight 1,000 to 1,499 grams 25 (43.1%), gestational age at birth between 30 and 34 weeks 30 (51.7%). At the time of PICC, the chronological age (days) was between zero days of life and six days 49 (76.5%). Prematurity 53 (91.4%) was the predominant medical diagnosis of hospitalization.

As for the progression of the PICC, 27 (42.2%) occurred in the right basilic vein, among them, 18 (66.7%) were the only punctureable vein, 7 (25.9%), due to the random choice of the basilic, and two (7.4%) due to unsuccessful puncture of the cephalic vein. Among 37 (57.8%) insertions in the cephalic vein, 17 (46%) were the only puncture and 15 (40.5%), the result of the random choice of the cephalic and 5 (13.5%), due to the failure in puncture of the basilic. Therefore, there was success and, in the first puncture, 57 (89.06%) insertions and 7 (10.94%), in the second puncture.

Table 1 highlights the frequency of progression of the catheter with and without maneuver through the basilic and cephalic veins.

Table 1 - Distribution of catheter insertions in basilic vein and right cephalic vein, with and without application of the shoulder movement maneuver for progression of the catheter. Fortaleza, CE, Brazil, 2014

Vein	Progressed without maneuvers	Progressed with maneuvers	Has not progressed	Total	p-value*
	n(%)	n(%)	n(%)	n(%)	
Basilic	19(70.4)	8(29.6)	-	27(100.0)	<0.001
Cephalic	9(24.3)	20(54.1)	8(21.6)	37(100.0)	
Total	28(43.8)	28(43.8)	8(12.4)	64(100.0)	

*Fisher's exact test

The basilic vein was more favorable to the progression of the PICC, as 70.4% of insertions progressed without maneuver and 100.0% after using the maneuver. There was a statistically significant association between the use of the maneuver and the progression of the PICC, especially when the insertion was performed in the cephalic vein, 24.3% of the insertions progressed without maneuver, 54.1% after maneuver.

Table 2 shows the progression of the PICC, in the basilic and right cephalic veins of newborns, before and after application of the three steps of the maneuver.

Table 2 - Number of catheter progressions after applying the steps of the shoulder movement maneuver in newborns. Fortaleza, CE, Brazil, 2014

Steps	Before the intervention Pre-test		Post intervention Post-test		p-value*
	Has not progressed	Progressed	Has not progressed	Progressed	
	n(%)	n(%)	n(%)	n(%)	
First	36(100.0)	-	21(58.3)	15(41.7)	< 0.001
Second	21(100.0)	-	9(42.9)	12(57.1)	< 0.001
Third	9(100.0)	-	8(88.9)	1(11.1)	> 0.999

*McNemar test (binomial model)

The application of the first and second steps of the maneuver resulted in a significant change in the progression of the catheters. Once the first two steps of the maneuver were applied, the addition of the third step did not influence PICC progression as much.

Table 3 shows the distribution of catheter progressions, in the first and second steps of the maneuver and tip location.

Only one catheter presented peripheral positioning when the progression occurred without the use of maneuvers. The distribution of the catheter positioning after applying the first step of the maneuver (73.3% - 26.7%) was similar to the composition observed after the second step of the maneuver (75.0% - 25.0%).

Table 3 - Distribution of catheter progressions, observed without maneuvers and after the first and second steps of the maneuver and positioning of the catheter tip. Fortaleza, CE, Brazil, 2014

Procedure steps	Placements			p-value*
	Central	Peripheral	Total	
	n(%)	n(%)	n(%)	
No maneuvers	27(96.4)	1(3.6)	28(100.0)	0.032
After the first step of the maneuver	11(73.3)	4(26.7)	15(100.0)	
After the second step of the maneuver	9(75.0)	3(25.0)	12(100.0)	
Total	47(85.5)	8(14.5)	55(100.0)	

*Pearson's Chi-Square Test

Discussion

This research has the following limitations: the absence of a sample calculation; the association between progression of the catheter and the material made, silicone and polyurethane; the application of the maneuver on the left arm; the use of each step of the maneuver separately; the small number of newborns who received the third step of the maneuver; and the effect of the sequence of maneuver steps on progression.

Through the statistical analysis, the priceless value of the maneuver was perceived, due to favoring the progression of the PICC in newborns through the right basilic and cephalic vein, up to the vena cava, being easy to apply, without tissue injuries or additional expenses. It has the advantage that the use of the maneuver can avoid improper positioning; consequently, facilitate compliance with intravenous therapy, thus contributing to quality of life and health promotion of hospitalized newborns.

It was observed that the non-progression of the catheter before the maneuver, through the right basilic and cephalic veins, in the right hemiclavicular region, occurred in more than half of the catheterizations (56.3%), with the cephalic one being the main responsible for the non-progression (75.7%). Such a result may be associated with the vessel's own cha-

racteristics, such as vein tortuosity[3] and angulation of insertion of the cephalic vein into the axillary vein, hindering progression, inadequate positioning and leakage[3].

Regarding the right basilic vein, it favored the progression of the PICC without maneuvers in 70.4% of catheterizations. It is emphasized that this vein is more rectilinear, gauge and short, has a lower implantation angle in the axillary vein and a smaller number of valves[3].

It was observed that although the basilic vein favored PICC progression by 100.0%, 29.6% of insertions only progressed after using the maneuver. Thus, the nurse, when trained and qualified to insert PICC in newborns, knowing how to apply the maneuver, contributes to increasing the chances of progression and central positioning. It is important to highlight the recognition of the role of the vascular access nurse in the health team, with collaboration and respect among the health professionals, positively influencing patient safety [8], in addition to the fact that the whole team needs to be prepared in order to avoid damage and allow the catheter to remain as long as possible[9].

Although all catheters have progressed in basilic after the three steps of the maneuver, it is emphasized that of the catheters that did not progress after the first and second steps, the majority occurred in the cephalic vein and did not progress after the third step of the maneuver and few in a basilic vein. It is inferred, then, that the third step did not contribute to the progression of the PICC in the cephalic vein. It is pertinent to examine anatomical aspects of the shoulder joint, for a better understanding of the effect of the third step.

When evaluating each step of the maneuver separately, applied to newborns in which the catheter did not progress, there was similarity between the amount of catheter that progressed after the first and second steps of the maneuver, in basilic and right cephalic, with a value of $p<0.001$. The fact that only the first or second step of the maneuver was not applied was not evaluated if there was a cumulative effect on the progression for catheters that received the first and then the second step.

When looking for an association between the three steps of the maneuver and the progression of the catheter in basilic and right cephalic; there was statistical significance, $p<0.001$, in the first and second steps, inferring that these contributed to the success of the maneuver.

In this investigation, the partially satisfactory outcome of the maneuver refers to the improper positioning of the catheter, that is, the catheter that progressed to peripheral positioning (unwanted outcome). Although the progression of the catheter in the right hemiclavicular region has been facilitated by the application of the maneuver, it is important to assess the final positioning of the tip of the PICC, by chest X-ray, observing progression to the superior vena cava[3].

When associating progression without maneuver and after the first two steps of the maneuver and central and peripheral positioning, statistical significance was found for progression without maneuver and central positioning, demonstrating that peripheral positioning is rare, when progression occurs without using the maneuver. Most of the inserted catheters progressed to central positioning after applying the maneuver, showing that the movement of the shoulder facilitates the progression of the catheter in the right hemiclavicular region, through the right basilic and cephalic veins in newborns.

Although the maneuver made possible the progression of most of the catheters, peripheral positioning was found in some insertions, emphasizing the importance of further research, to avoid peripheral positioning and non-elective withdrawal, as it is a fragile and susceptible clientele.

Research carried out with 563 PICC insertions in newborns, in São Paulo, Brazil, to develop a logistic regression model with risk factors for non-elective PICC removal, found that the non-central positioning of the tip presented twice the risk non-elective removal[10].

Research carried out with neonates in Vitória, Brazil, showed that the location of the PICC tip was central in 81 (60.6%) of the insertions[11]. These data show the importance of the central positioning of the catheter, which enables the infusion of the proposed therapy, mitigating the risks of tissue injuries, resulting from the infusion of irritating and/or vesicant substances in a peripherally positioned catheter.

There is a need for further research, with a view to the development of technologies capable of solving the poor positioning of the PICC in newborns and, consequently, mitigating potential complications[12], therefore, the shoulder movement maneuver becomes one of these possibilities.

The importance of verifying the success of each step of the maneuver in the progression of the catheter is pointed out. Shoulder elevation and protraction facilitate the progression of the catheter in the right hemiclavicular region, through the right basilic and cephalic veins, in newborns, showing that shoulder movement is a viable strategy in nursing care for the newborn. And this care favors good practices with the PICC, contributing to patient safety and quality of care[13].

By focusing on the aspect of catheter placement in neonates, a retrospective cohort survey, carried out in neonatal units in the United States, showed that most of the studied catheters were centrally located at the time of insertion (>90.0%), however, did not perform routine surveillance of the tip position, therefore, tip migration cannot be excluded[14].

At the end of the research, it was decided to name the maneuver as Shoulder Lifting, Protraction and Lowering Maneuver or EPA Maneuver. The maneuver was created from the professional practice of a nurse who provides assistance to high-risk newborns, with 10 years of experience in Neonatology. It is recommended that studies on this maneuver be deepened and applied to Neonatology, since this positioning consists of technology of scientific relevance, aiming at improving and incorporating the practice of teaching, researching and caring for newborns, with a view to preventing complications, promote the health and safety of patients[15].

Conclusion

The insertion of a Peripherally Inserted Central Catheter in newborns is more associated with progression without maneuvers through the right basilic vein and progression with maneuvers through the right cephalic. Shoulder elevation and protraction in newborns facilitated the progression of the catheter through the basilic and right cephalic, being statistically significant. The first and second steps of the maneuver (elevation and protraction) favored the central positioning.

Collaborations

Nobre KSS contributed to the collection, organization, data interpretation, work design, writing and approval of the final version to be published. Cardoso MVLML collaborated with the design, interpretation of data, writing and approval of the final version to be published. Rodrigues EC and Melo GM assisted in the relevant critical review of the intellectual content and approval of the final version to be published.

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