

Neonatal Peripherally Inserted Central Catheters (PICCs): Complication Rates & Average Duration of Stay Related Catheter Tip Location

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Abstract

Objectives: Present study was performed with an objective to compare complication rates & average duration of stay between, peripherally located catheter tip, non-centrally (intermediate) located catheter tip and centrally located catheter tip of percutaneously inserted central catheter (PICCs) in neonates. **Material and methods:** Present retrospective cohort study was performed at level III neonatal care in neonates who underwent PICCs placement through saphenous vein. We analyzed the data of the neonates from our NICU from March 2009 to September 2009 who underwent PICCs placement. Patients demographics, catheter duration and catheter complications were analyzed retrospectively. Catheter tip location was determined by X-ray. Difference in the complication rates, premature removal rates and average duration of stay in peripheral, non-central (intermediate) and central groups were analyzed. **Results:** Data of total 49 neonates was analyzed. Of the 49 PICCs, in 16 (32.6%) catheter tip was in peripheral location, in 23 (46.9%) catheter tip was in non-central (intermediate) location and in 10 (20.4%) catheter tip was central location. The peripheral group had complication rate of 81.2% (13/16), while the intermediate group had complication rate of 26% (6/23), and central group had no complications. Average duration of stay of catheter in peripheral group was 7.1 days, intermediate group was 10.7 days, and central group was 28.3 days. **Conclusion:** Placement of the tip of the PICCs beyond the sapheno femoral junction even though not central is acceptable in standard care of newborn.

Keywords: Percutaneously inserted central catheter (PICCs); Neonatal.

Introduction

Safe and reliable vascular access is an essential element of modern-day health care. In recent years peripherally inserted central catheter for intermediate and long-term venous access has steadily grown.

Peripherally inserted central catheters (PICCs) have become increasingly popular in the treatment

of the neonates in the intensive care units. A PICCs defined as a catheter inserted percutaneously via peripheral vein with the tip residing in central vein.¹ We accept definition of central position of tip if it lies in SVC, high in IVC or RA (based on vessel diameter, blood flow estimates, and physiologic flow dynamics), peripheral position of tip if it lies in saphenous vein, cephalic vein or axillary vein, and intermediate position of tip if it lies in subclavian, femoral, iliac, jugular vein.

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PICCs are commonly used in neonatal practice, where central venous access is often necessary for weeks. PICCs cannot always be advanced to a central venous location and are occasionally left with the catheter tip in noncentral position. There is increasing popularity in placing so called "mid-line catheter" or "long IVs" whose catheter tips are intentionally left in the noncentral position.² It has been suggested that centrally placed catheter tips were associated with fewer complications than non-centrally placed catheter tips.¹

We hypothesized that in case of PICCs inserted via long saphenous vein, if that catheter tip crosses the sapheno-femoral junction (lying in to femoral vein) even if it is not lying high in inferior vena cava would result in decreased in premature removal rates and complication rates, compared with central catheter tip lying in saphenous vein or in tributaries of vein (stuck at the sapheno-femoral junction).

The position of these lines is important because incorrect placement may be associated with complications. Importance must be paid to the correct positioning of the line, preferably with the tip lying within superior vena cava, or inferior vena cava, outside the cardiac chambers. Suboptimal or incorrect positioning can result in variety of complications including perforation, which may lead to extravasation of intravenous fluid, pleural and peritoneal effusion and more seriously cardiac tamponade. The course of the line and positioning of tip is usually assessed using plain film radiography, traditionally using film screen combinations.³

PICCs related sepsis is serious complication and its risk is increased by longer duration of catheterization, and is probably influenced by catheter material, frequency of line break for infusion change and drug injection, the presence of multiple lumens and by technique of catheter fixation. The rate of infection can be reduced by staff education.³

Delayed effusion into body cavity can occur, probably because of damage to the vascular wall by infused fluid. It may develop after catheter passes into small vein and then cause extravasation.³

Materials and Methods

A retrospective study was performed over the period of six months from March 2009 to September 2009. All neonates of the neonatal units at our hospital who required a percutaneous long line through saphenous vein during this period were included in

the study. Long lines were inserted by neonatologist using standard procedure. Vygon Premicath 28 G with splitting needle was used in all neonates. After insertion plain radiograph was taken to ascertain the line position. The position of the tip of long line was identified by using plain radiograph. Assessment was made to determine the tip of the PICCs. The reference points by which the position of the tip of the catheter was determined radiologically were the vertebral bodies, medial end of the head of the femur and the midline of the body plane.

Three groups were made according to location of the tip of the catheter radiologically:

Group 1 Central: Tip of the PICCs resides in the superior vena cava (SVC), or high inferior vena cava (IVC) at or above the level of diaphragm.

Group 2 Non-central (intermediate): Tip of the PICCs resides in the femoral vein or iliac vein (crossed the saphanofemoral junction); above the medial end of the head of the femur.⁴

Group 3 Peripheral: Tip of the PICCs resides in saphenous vein (if tip lies anywhere below the head of the femur).

Retrospective data was collected on complications including leaking at the PICCs insertion, phlebitis (erythema, swelling, pain, or palpable cord), infection (positive tip catheter cultures/positive blood culture), and catheter occlusion (inability to infuse or withdraw). All complications necessitated catheter removal. We also looked at premature removal of the catheter rates (removed when needed) in relation to catheter tip location. Average duration of the stay of the catheter was calculated and compared in relation to location of the tip catheter.

Statistical Analysis

All analyses were performed using statistical software, version 13. For the complications rates and premature removal rates. Pair wise comparison of frequency between Group 1 and Group 2 was done using test of proportion. The *p*-values are recorded.

The patient's characteristics were examined univariately. For simple comparison between central and non central and peripheral PICCs the χ^2 test was used for categorical data. For the comparison of duration of the stay of the PICCs in different groups, one-way analysis of variance (ANOVA) was applied. When ANOVA showed a significant difference, Turkey's test for comparison was applied.

Results

From March 2009 to September 2009, data from a total of 49 PICCs were analyzed.

Table 1 shows that 15 neonates (30.6%) were between 28 and 32 weeks, 18 neonates (36.7%) were between 33 and 37 weeks and 17 neonates (34.6%) were >37 weeks of gestation.

Table 1: Distribution of neonates according to gestational age

Gestational age	No. of neonates	%
28-32	15	30.6
33-37	18	36.7
>37	17	34.6
Total	49	100.0

Number of complications were more (81.2%) in the neonates in whom the tip of the PICCs were in peripheral location, and the percentage of complication decreased to 26% if the tip of the PICCs was in intermediate position in femoral vein (crossed the sephano-femoral junction) though not in the central position. There was no complication if the tip of the PICCs were lying in the central position. Pair wise comparison of frequency between Group 1 (Peripheral) and Group 2 (Non-central/Intermediate) was done using test of proportion. The *p* values are recorded it was significant (<0.001), indicating non-central/intermediate group has reduced rate of complication than peripheral group (Table 2).

Number of premature removal was more frequent in the neonates in whom the PICCs were peripheral in location (81.2%) and in neonates in whom the PICCs were though not in central position but crossed the sephano-femoral junction lying in the femoral vein the no. of premature removal is decreased to (26%). Pair wise comparison of frequency between Group 1 and Group 2 was done using test of proportion. The *p*-values was significant (<0.001), indicating non-central group has reduced rates of premature removal. Average duration of the stay was 6.1 days in peripheral group and it increased to intermediate group to 10.7 days, while it was 27.8 days in central group. (Table 2)

Table 2: Complication rates, premature removal rates & Average duration of stay: Peripheral, Intermediate & Central groups

Complications	Tip located in peripheral position (Group 1 peripheral) <i>n</i> = 16	Tip in the femoral vein but not central (Group 2 intermediate) <i>n</i> = 23	Tip Crossed the junction and central (Group 3 central) <i>n</i> = 10	<i>p</i> -value
Swelling	4 (25%)	3 (13%)	0	<0.001
Occlusion	6 (37.5%)	3 (13%)	0	
Phlebitis	3 (18.2%)	0	0	
Total no. of complication	13 (81.2%)	6 (26%)	0	
No. of premature removal (Removed when needed)	13 (81.2%)	5 (26%)	0	<0.001
Average duration of stay	6.5 days	10.7 days	27.8 days	

Table 3 shows mean duration of the stay of the PICCs in three groups. It shows that mean PICCs duration was greater for the non-central /

intermediate group(10.7 ± 4.7 days) than peripheral group (6.5 ± 2.5 days).

Table 3: Duration of stay of the PICCs: between peripheral, non-central, central groups

Duration of stay of the PICCs	Tip located in peripheral position (Group 1) <i>n</i> = 16	Tip in the femoral vein but not central (Group 2 non-central/intermediate) <i>n</i> = 23	Tip Crossed the junction and central (Group 3) <i>n</i> = 10
Mean	6.56 days	10.78 days	27.8 days
SD	2.5	4.72	8.69

Discussion

In our NICU PICCs were inserted in lower limb in saphenous vein, reasons being:

- (1) convenient for nursing staff to maintain the position of the baby.
- (2) changes in upper extremity position cause migration of PICCs.

We encountered difficulties in negotiation of the catheter to central location. The reasons could be venous valves, venous tortuosity, veno-spasm and the tip entering into smaller tributaries.

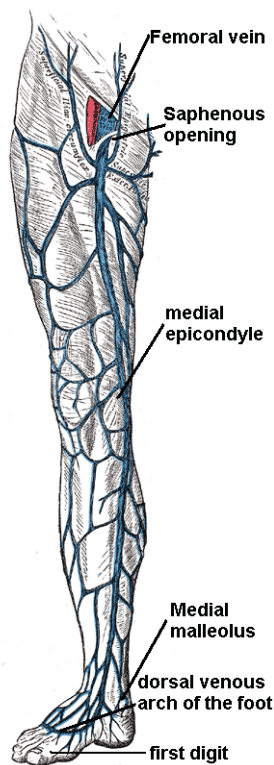


Fig. 1: Course of long saphenous vein.

Figure 1 shows the course of the long saphenous vein and anatomical landmark with venous tortuosity and multiple tributaries which can make the negotiation difficult. Table 4 demonstrates that number of venous valves are more below the saphenofemoral junction, which make the negotiation difficult beyond the saphenofemoral junction.

There has not been clear evidence in the literature of an association between catheter tip location and complication rates in neonatal PICCs. Our study demonstrates that central catheter tip location was important factor associated with reduced complication rates, it also demonstrates that though the tip of PICCs is not central but if it is in intermediate vein (out of peripheral vein) the complications rates are decreased and average duration of the stay is increased.

The position of these lines is important because incorrect placement may be associated with complications. Recognized complications of PICCs include catheter occlusion, phlebitis, extravasation, thrombosis and infection.^{5,6,7,8}

Importance must be paid to the correct positioning of the line, preferably with the tip lying within superior vena cava, or inferior vena cava, outside the cardiac chambers and beyond the peripheral vein. Suboptimal or incorrect positioning can result in variety of complications including perforation, which may lead to extravasation of intravenous fluid, pleural and peritoneal effusion and more seriously cardiac tamponade. The course of the line and positioning of tip is usually assessed using plain film radiography.⁹

We accept definition of central position of tip if it lies in SVC, high in IVC or RA (based on vessel diameter, blood flow estimates, and physiologic flow dynamics) and noncentral position of tip if it

Table 4: Number of valves in veins of lower limb

	Number of valves
Inferior vena cava	0
Common iliac vein	0
Internal iliac vein	0
External iliac vein	1
Femoral vein	1
Superficial femoral vein	1-4
Profunda femoris vein	0
Popliteal vein	1
Long saphenous vein	1
● reinforced ostial valve	2-3
● reinforced trunk valves	6-20
● fine, transparent valves	6-20

lies in brachycephalic, jugular, subclavian, femoral, iliac vein, and peripheral if tip lies cephalic, axillary or saphenous vein (Fig. 2). The central locations represent the region of the highest blood flow.¹⁰⁻¹⁶



Fig 2: Tip located in saphenous vein (Peripheral group) position.



Fig 3: Tip placed in femoral vein crossed the junction but not central (Intermediate group).



Fig. 4: Tip placed high in IVC (central group).

In our study there was no incidence of pericardial effusion, cardiac tamponade as even in centrally located tip position group as the tips were outside the heart. We report that in neonatal PICCs placement, even if the tip of the catheter is not in central position as it is difficult to negotiate, but in intermediate vein (out of the peripheral vein) it serves the purpose in care of LBW babies without life-threatening complication (e.g. pericardial effusion, cardiac tamponade, sepsis) (Fig. 3). The use of the PCCs should be encouraged by looking at their multiple advantages.

Decreased complication rates, decreased rates of premature removal and increased average duration of stay of PICCs with centrally and noncentrally versus peripherally located PICCs tip is likely related to a combination of factors including vessel size, blood flow rate, turbulent flow, and endothelial injury. Smaller vein diameter result in decreased blood flow, causing turbulence which increases the risk of endothelial injury, thrombophlebitis and thrombosis.^{17,18}

Addition of this study to exiting knowledge. Complication rates, premature removal rates are decreased and average duration of stay is increased once the tip of the catheter advances high in intermediate vein (out of the peripheral vein) even though not central (Fig. 4). Non-centrally (in intermediate vein) placed catheter tips are associated with fewer complications than peripherally placed catheter tips.¹⁹

Conclusion

Complication rates, premature removal rates are decreased and average duration of stay is increased once the tip of the catheter advances high in intermediate vein (out of the peripheral vein) even though not central. Centrally and non-centrally (in intermediate vein) placed catheter tips are associated with fewer complications and prolonged duration of stay than peripherally located catheter tips. Placement of the tip of the PICCs beyond the sapheno femoral junction even though not central is acceptable in standard care of newborn.

Conflict of Interest: none

Source of Support: Nil

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