Aims: A peripherally inserted central catheter (PICC) is required in preterm neonates, especially those with low birth weight. However, PICC is associated with various complications resulting in increased morbidity and mortality. The objective of the study was to evaluate the association between PICC tip position and complications in neonates.

Materials and Methods: One hundred neonates were recruited in a 1-year hospital-based, longitudinal, observational study. Radiographs were obtained to confirm the position of the catheter tip as central or noncentral in relation to vertebral level (T9–L5). The variables studied included site of insertion, duration of stay of PICC, time of removal, reason for removal, and associated complications. These were compared between the groups using SPSS version 20. Fisher’s exact test was used to find the associations.

Results: Most of the neonates were preterm (78%) and 81% were low birth weight. Catheter was placed in the right lower limb in most of the neonates (85%), and the catheter tip was central in position in 84% of neonates. The incidence of complications was observed in 29%. Noninfectious complications were common (26%) compared to infectious (3%). The most frequent PICC-induced complication was phlebitis (11%). Incidence of complications (P = 0.020), especially occlusion (P = 0.008), was significantly higher in neonates with noncentral catheter tip compared to the central tip.

Conclusion: We observed a high incidence of PICC-induced complications in neonates, with phlebitis being most common. Further, the incidence of complications is influenced by noncentral tip position.

Keywords: Bloodstream infections, catheter occlusion, catheterizations, central catheter complications, peripheral

Submitted: 13-May-2019.
Revised: 28-Jun-2019.
Accepted: 08-May-2020.
Published: 01-Sep-2020.

INTRODUCTION

Peripherally inserted central catheter (PICC) is used increasingly in critically ill patients in the neonatal intensive care unit (NICU), particularly in preterm newborns.[1,2] They are required to maintain the venous access for longer durations and allow safe infusion of medication, hypertonic solutions, and total parenteral nutrition into central veins.[3,4]

In addition to several benefits attributed to PICC, certain risks are involved in use of this device. The complications occur during insertion, when catheter moves through venous pathway, during maintenance, and during removal of catheter. Complications can be noninfectious such as obstruction, catheter rupture, punctured vessels, overflow, thrombosis, hydrothorax, or infectious, especially systemic sepsis.[1,4,5]

Although PICC is frequently used in neonates, the relationship between position of catheter tip and complications in this population remains

Address for correspondence: Dr. Kshitija Patil,
A-18, Ambekar Nagar, The Maharashtra CHSL, GD Ambekar Marg, Parel - 400 012, Mumbai, Maharashtra, India.
E-mail: dr kp56@gmail.com

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Patil K, Dhaded SM, Bhandankar M. A 1-year study on association between peripherally inserted central catheter tip position and complications in neonates. J Indian Assoc Pediatr Surg 2020;25:276-9.
unclear.[1] Limited studies have been conducted to determine the relationship between catheter tip position and complications in the Indian NICU settings. Hence, the present study aims to determine the relationship between PICC tip position and risk of associated complications.

**Materials and Methods**

One-year longitudinal, observational study was conducted from January 2015 to December 2015. The sample size was calculated using the formula for prevalence: \( n = \frac{4pq}{d^2} \) (\( p = 50\% \) [as the exact prevalence is not known], \( q = 100 - p = 50\% \), and \( d = \) absolute error = 10\% \( p = 5\% \)) and hence \( n = 400 \). However, the rate of insertion of PICC in our institution is 25\%. Hence, a total of 100 neonates admitted to the NICU with PICC inserted during their stay were enrolled in the study (inclusion criterion). Neonates with PICC placed outside the NICU and the cases in which follow-up was not possible until discharge or removal of catheter were excluded (exclusion criterion). After explaining purpose of the study, written informed consent was obtained from all the participants. The sociodemographic data, detailed history, and systemic examination were recorded in a predesigned and pretested proforma. Ethical clearance was obtained from the institutional ethical committee.

PICC was inserted with all aseptic precautions, and radiograph was obtained. The tip position was classified as central (between the 9th thoracic vertebra [T9] and the 5th lumbar vertebra [L5]) or noncentral (positions other than central).[6,7]

The variables including site of insertion, duration of stay, reason for removal, and associated complications were recorded. The trained nursing staff monitored and identified the catheter-associated complications and recorded them in the proforma. Catheter-related bloodstream infections, occlusion, phlebitis, leakage, and mechanical complications such as dislodgement were identified as catheter-associated complications.

The data were analyzed using SPSS version 20 (Armonk, NY: IBM Corp). The association between PICC tip position and complications was analyzed using Fisher’s exact test. \( P \leq 0.05 \) was considered statistically significant.

**Results**

Majority of the neonates were preterm (75\%) and 81\% were low birth weight. Other demographic characteristics of the study are detailed in Table 1. The incidence of catheter-induced complications was observed in 29\% of the neonates. The most common complication was phlebitis (11\%), followed by occlusion (10\%), mechanical complication (3\%), infections (3\%), and leakage (2\%). The incidence of complications was significantly high in neonates with noncentral tip position (\( P = 0.028 \); odds ratio = 4.1142; confidence interval = 1.36–12.46). Noncentral catheter tip position was significantly associated with occlusion. As shown in Table 2, odds of having complications is four times more for the subjects with noncentral catheter tip position compared to central position of catheter tip. Odds of having occlusion complication is seven times more for the subjects with noncentral catheter tip position compared to central tip position of catheter tip.

**Discussion**

In the present study, we observed the relationship between PICC tip position and associated complications in neonates. We found that complications occurred in 29% of the neonates with PICC. Singh et al.[8] observed complications in 23% of the neonates and Jain et al.[9] in 36% of the neonates.

The noninfectious complications including occlusion, phlebitis, leakage, and mechanical complications accounted for 89.6% of the total complications while infections were 10.3% of total complications. Hoang et al.[10] reported 62.4% of noninfectious complications including phlebitis, occlusion, and leakage and 37.5% of infectious complications.

### Table 1: Incidence of complications

| Variable                  | Absent, \( n (%) \) | Present, \( n (%) \) | \( P \) |
|---------------------------|----------------------|-----------------------|--------|
| Gender                    |                      |                       |        |
| Male                      | 45 (75)              | 15 (25)               | 0.280  |
| Female                    | 26 (65)              | 14 (14)               |        |
| Gestational age (weeks)   |                      |                       |        |
| <34                       | 26 (65)              | 14 (35)               | 0.137  |
| 34-37                     | 27 (71.05)           | 11 (28.90)            |        |
| >37                       | 18 (81.82)           | 4 (18.18)             |        |
| Birth weight (g)          |                      |                       |        |
| <1000                     | 3 (75)               | 1 (25)                | 0.137  |
| 1000-1500                 | 18 (81.82)           | 4 (18.18)             |        |
| 1501-2499                 | 37 (67.27)           | 18 (32.73)            |        |
| ≥2500                     | 13 (68.42)           | 6 (31.58)             |        |
| Site of catheter insertion|                      |                       |        |
| Left lower limb           | 9 (60)               | 6 (40)                | 0.235  |
| Right lower limb          | 62 (72.94)           | 23 (27.06)            |        |
| Catheter tip position     |                      |                       |        |
| Central                   | 64 (76.19)           | 20 (23.81)            | 0.020  |
| Noncentral                | 7 (43.75)            | 9 (56.25)             |        |
| Duration of catheter stay (days) |               |                       |        |
| <7                        | 10 (66.67)           | 5 (33.33)             | 0.713  |
| 7-14                      | 50 (73.53)           | 18 (26.47)            |        |
| >14                       | 11 (64.71)           | 6 (35.29)             |        |
The noncentral catheter tip position was significantly associated with the incidence of complications ($P = 0.028$; OR = 4.11; CI = 1.36–12.46). Similarly, Jain et al.\cite{9} observed a higher rate of complication in patients with noncentral tip position ($P = 0.001$).

Among individual complications related to tip position, occlusions were significantly higher in neonates with noncentral tip position ($P = 0.020$). However, other complications including phlebitis, leakage, mechanical complications, and infections were not influenced by the tip position ($P > 0.05$). Jain et al.\cite{9} also reported that infectious and mechanical complications were not influenced by the tip position ($P > 0.75$).

Gender, gestational age, birth weight, dwelling time, and site of insertion did not significantly influence the incidence of complications. Similar observations were made by Singh et al.\cite{8} wherein the association was not established between gestational age and infectious and noninfectious complications ($P = 0.137$).

A lower incidence of PICC-induced complications has been reported in recent studies. This can be attributed to the technological advancements, improved sterile barrier precautions, and evidence-based catheter management in selected populations.\cite{11-14}

**Table 2: Association of catheter tip position with complications**

| Variable          | Tip position | Central, $n$ (%) | Noncentral, $n$ (%) | OR (CI)            |
|-------------------|--------------|------------------|---------------------|--------------------|
| Overall complications                      | 64 (76.19) | 7 (43.75) | 4.1142 (1.3585–12.4595) |
| Absent | 64 (76.19) | 7 (43.75) | 4.1142 (1.3585–12.4595) |
| Present | 20 (23.81) | 9 (56.25) |                          |
| Occlusion                      | 79 (94.05) | 11 (68.75) | 7.1818 (1.787–28.8581) |
| Absent | 79 (94.05) | 11 (68.75) | 7.1818 (1.787–28.8581) |
| Present | 5 (5.95) | 5 (31.25) |                          |
| Phlebitis                      | 75 (89.29) | 14 (87.50) | 1.1905 (0.2320–6.1064) |
| Absent | 75 (89.29) | 14 (87.50) | 1.1905 (0.2320–6.1064) |
| Present | 9 (10.71) | 2 (12.50) |                          |
| Leakage                      | 84 (97.67) | 16 (100) | 1.0242 (0.0469–22.3271) |
| Absent | 84 (97.67) | 16 (100) | 1.0242 (0.0469–22.3271) |
| Present | 2 (2.33) | 0 |                          |
| Mechanical complications                      | 82 (97.62) | 15 (93.75) | 2.7333 (0.2329–32.0812) |
| Absent | 82 (97.62) | 15 (93.75) | 2.7333 (0.2329–32.0812) |
| Present | 2 (2.38) | 1 (6.25) |                          |
| Infections                      | 82 (97.62) | 15 (93.75) | 2.7333 (0.2329–32.0812) |
| Absent | 82 (97.62) | 15 (93.75) | 2.7333 (0.2329–32.0812) |
| Present | 2 (2.38) | 1 (6.25) |                          |

OR: Odds ratio, CI: Confidence interval

**Conclusion**

The incidence of complications in the neonates with PICC was 29%. Noncentral catheter tip position resulted in significantly increased incidence of complications, particularly occlusion.

**Acknowledgments**

All the authors have contributed equally in the preparation of the manuscript.

**Financial support and sponsorship**

Nil.

**Conflicts of interest**

There are no conflicts of interest.

**References**

1. de Camargo PP, Kimura AF, Toma E, Tsunechiro MA. Initial placement of the peripherally inserted central catheter’s tip in neonates. Rev Esc Enferm USP 2008;42:723-8.
2. Tawil KA, Eldemerdash A, Hawthol KA, Laimoun BA. Peripherally inserted central venous catheters in newborn infants: Malpositioning and spontaneous correction of catheter tips. Am J Perinatol 2006;23:37-40.
3. Chlebicki MP, Teo EK. Review of peripherally inserted central catheters in the Singapore acute-care hospital. Singapore Med J 2003;44:531-5.
4. Camara D. Minimizing risks associated with peripherally inserted central catheters in the NICU. MCN Am J Matern Child Nurs 2001;26:17-21.
5. Sastre JL, Colomer BF, Cotallo GC, Aparicio AR. Prospective study about percutaneous catheters in neonates. Group of Castrillo hospitals. An Pediatr 2000;53:138-47.
6. 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;110:131-6.
7. Fong NI, Holtzman SR, Bettmann MA, Bettis SJ. Peripherally inserted central catheters: Outcome as a function of the operator. J Vasc Interv Radiol 2001;12:723-9.
8. Singh A, Bajpai M, Panda SS, Jana M. Complications of peripherally inserted central venous catheters in neonates: Lesson learned over 2 years in a tertiary care centre in India. Afr J Paediatr Surg 2014;11:242-7.
9. Jain A, Deshpande P, Shah P. Peripherally inserted central catheter tip position and risk of associated complications in neonates. J Perinatol 2013;33:307-12.
10. Hoang V, Sills J, Chandler M, Busalani E, Clifton-Koeppel R, Modanlou HD. Percutaneously inserted central catheter for total parenteral nutrition in neonates: Complications rates related to upper versus lower extremity insertion. Pediatrics 2008;121:e1152-9.
11. Grau D, Clarivet B, Lothél A, Bornmart S, Parer S. Complications with peripherally inserted central catheters (PICCs) used in hospitalized patients and outpatients: A prospective cohort study. Antimicrob Resist Infect Control 2017;6:18.
12. Yap YS, Karapetis C, Lerose S, Iyer S, Koczwar B. Reducing the risk of peripherally inserted central catheter line complications in the oncology setting. Eur J Cancer Care (Engl) 2006;15:342-7.
13. Maki DG, Kluger DM, Crnich CJ. The risk of bloodstream infection in adults with different intravascular devices: A systematic review of 200 published prospective studies. Mayo Clin Proc 2006;81:1159-71.
14. Tian G, Zhu Y, Qi L, Guo F, Xu H. Efficacy of multifaceted interventions in reducing complications of peripherally inserted central catheter in adult oncology patients. Support Care Cancer 2010;18:1293-8.