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Complications of peripherally inserted central venous catheters in neonates: Lesson learned over 2 years in a tertiary care centre in India

Amit Singh, Minu Bajpai, Shasanka Shekhar Panda, Manisha Jana[1]

ABSTRACT

Background: The objective of this study was to assess the complications of peripherally inserted central venous catheters (PICC) in neonates admitted to neonatal surgical intensive care unit (NSICU). **Patients and Methods:** Retrospective analysis of 237 neonates admitted to NSICU from January 2010 to December 2011 was done. **Results:** Mean age at presentation was 5.8 days and mean weight was 1.94 kg. Mean number of attempts was 1.14, mean duration of insertion 8.4 min and mean duration of patency of catheter 3.14 days. Most common site of catheter insertion was upper extremity (basilic followed by cephalic). Overall complications were seen in 47 (23%) cases. Infectious complications were seen in 22 (10.7%) and non-infectious in 25 (12.2%) cases. Significant correlation existed between non-infective complications and insertion site ($P = 0.03$) and duration of PICC ($P = 0.04$). **Conclusion:** Precautions should be taken and position must be confirmed during and after PICC insertion to avoid undue complications.

Key words: Catheter related sepsis, complications, peripherally inserted central venous catheters, total parenteral nutrition

INTRODUCTION

Peripherally inserted central venous catheters (PICC) have been extensively used in neonates for administration of total parenteral nutrition (TPN). Approximately, 8.3-33% of neonates admitted to an intensive care unit require PICC insertion.[1,2] Use of these catheters is associated with complications related not only to catheter insertion, but also to its use. Infection rates in PICC have been reported to be 13/1000 catheter days.[1] The rate of central venous catheter infections in surgical newborns is reported to be 24%.[3]

Factors associated with complications of PICC are not well-described. Objective of this study was to assess the pattern of complications associated with PICC in neonates admitted to neonatal surgical intensive care unit (NSICU). This is the first paper to describe PICC usage and complications exclusively in surgical neonates.

PATIENTS AND METHODS

We retrospectively analysed the data of NSICU at our institute over a period of 2 years from January 1, 2010 to December 31, 2011. A total of 237 neonates was admitted for various surgical conditions during this period. Range of neonatal surgical conditions treated in our unit are pure esophageal atresia, tracheoesophageal fistula, congenital diaphragmatic hernia, intestinal atresias, abdominal wall defects, necrotising enterocolitis, conjoined twin, meconium ileus, posterior urethral valve, cystic lung diseases etc. Surgical patients such as gastroschisis, necrotising enterocolitis, short bowel syndrome etc., where we anticipate prolonged duration of parenteral nutrition and inability to be enterally fed were chosen for PICC insertion. A total of 204 PICC were inserted in 186 neonates following a uniform protocol with stress on asepsis. The optimal insertion site for each individual patient was chosen by the surgeon based on availability of suitable vein. All the operators were proficient in inserting catheters at all sites. Commonly used routes were ante-cubital (cephalic/basilic), popliteal, saphneous or femoral. Ultrasonic localisation was used in difficult situations. Post-PICC insertion X-ray without or with a contrast ie iohexol (linogram or tubogram)[4] depending upon calibre of catheter used was done in all cases to confirm the position of the catheter before starting TPN or intravenous (IV) fluids.

Departments of Paediatric Surgery, and [1]Radiodiagnosis, All India Institute of Medical Sciences, New Delhi, India

Address for correspondence:
Dr. Minu Bajpai,
Department of Paediatric Surgery, All India Institute of Medical Sciences, New Delhi - 110 029, India.
E-mail: bajpai2@hotmail.com

Standard central venous catheter care was provided by dedicated intensive care nurses. Insertion site was dressed as soon as some soakage/soiling noted. Back flow was checked every day in the morning before starting the TPN. Blood sampling from the PICC was avoided to decrease the rate of occlusion of PICC. PICC was removed as soon as any swelling or redness with clinical features of sepsis is noticed.

Complications were defined as infective (catheter related sepsis, sepsis, local wound infection) or non-infective (malposition, swelling, erythema, arterial cannulation, occlusion, dislodgement, pleural effusion). Criteria for removal of PICC (complications) were the presence of local swelling, presence of local erythema, absent backflow, features suggestive of catheter related sepsis. Catheter related sepsis was defined as strong clinical features of sepsis as per Goldstein criteria,[5] positive blood culture (drawn from separate site) in cases with PICC, positive catheter tip culture (post-removal), purulent discharge from the catheter insertion site, local erythema and local rise of temperature. Antibiotics were changed according to the culture and sensitivity in cases of positive cultures or arbitrarily in cases of negative culture keeping in mind the sensitivity pattern of common intensive care unit pathogens. Malposition was defined as catheter tip beyond cavoatrial junction in PICC of upper limb, renal veins (L2 vertebra) in PICC of lower limb after the catheter was initially placed in an optimal position and it later migrated to an undesirable position. Arterial cannulation was defined as arterial puncture occured immediately during insertion and the operator reinserted into the vein. Occlusion was defined as the inability to flush the PICC, absent back flow, obvious resistance to flow/flush. Phlebitis was defined as the presence of signs of venous inflammation responsive to conservative management (hot fomentation) without fever or systemic signs of infection. After removal, the tips of all catheters were sent for culture as a routine protocol. Data were maintained regarding the number of attempts, procedure time, number of dressings, number of days of catheter use, reason for removal, culture and sensitivity and treatment modification, if any.

The data analysis was performed using STATA software version 11 (STATA Corp LP Texas USA). The statistical tests applied were Chi-square test, Wilcoxon signed rank test. *P* value was calculated using fisher exact test, student's *t*-test and the value <0.05 was considered to be statistically significant.

RESULTS

Out of 186 neonates, 111 (59.6%) were male and 75 (40.3%) were female with M:F ratio of 1.5:1. Mean age of the neonate at the time of admission to our surgical newborn intensive care unit was 5.8 days (range 12 h to 27 days). Mean weight was 1.94 kg (range 1.87-3.19 kg). Mean age of gestation was 34 weeks (range 27-37 weeks). Mean number of attempts during PICC insertion was 1.14 (range 1-4), mean duration of PICC insertion procedure was 8.4 min (range 7-25 min), mean duration of patency of the catheter was 3.14 days (range 2-26 days). Most common site of catheter insertion was upper limb (basilic followed by cephalic vein). The details of PICC sites and related patients demographic profile are as shown in Table 1.

Overall complications were seen in 47 (23%) cases. Infectious complications were seen in 22 (10.7%) cases,

Table 1: Patient variables

	Basilic (%)	Cephalic (%)	Femoral (%)	Popliteal (%)
Site of insertion	124 (61)	22 (11)	46 (22)	12 (6)
No. of attempts				
1	86 (69)	15 (68)	39 (85)	9 (75)
2	25 (20)	4 (18)	5 (11)	2 (17)
>2	13 (11)	3 (14)	2 (4)	1 (8)
Indication for insertion	TPN (*n*=34)	TPN (*n*=7)	TPN (*n*=27)	TPN (*n*=9)
	AB (*n*=90)	AB (*n*=15)	AB (*n*=19)	AB (*n*=3)
Indication for removal	D (*n*=96)	D (*n*=12)	D (*n*=44)	D (*n*=9)
	C (*n*=32)	C (*n*=10)	C (*n*=2)	C (*n*=3)
Duration of stay in days	M (13)	M (*n*=12)	M (*n*=17)	M (*n*=9)
	R (9-18)	R (2-17)	R (6-26)	R (3-21)
Duration of insertion in minutes	M (11)	M (14)	M (19)	M (16)
	R (7-15)	R (8-22)	R (12-25)	R (7-25)
Length of hospital stay in days	M (15)	M (13)	M (13)	M (23)
	R (10-27)	R (9-23)	R (9-17)	R (12-38)

TPN: Total parenteral nutrition; AB: Antibiotics; C: Complications; D: Discharge; R: Range; M: Mean

out of which blood culture was positive in 9 (4.4%) cases. Most common organisms grown on blood culture were Gram-positive cocci in 6 (2.9%) followed by Gram-negative bacilli in 2 (0.9%) and fungus in 1 (0.4%) cases respectively. Catheter tip culture was positive in 7 (3.4%) cases. Of these seven cases, most common pathogen grown was coagulase negative *Staphylococci* in 5 (2.4%) cases, followed by Candida Albicans in 2 (0.9%) cases. In 6 (2.9%) cases, both blood culture and catheter tip culture were negative in spite of presence of features suggestive of local sepsis with phlebitis. Non-infectious complications were seen in 25 (12.2%) cases. Malposition of the catheter was observed in 11 (5.3%) cases [Figure 1]. All these cases required repositioning of catheter. Four cases developed pleural effusion (hydrothorax) [Figure 2] following TPN in superior extremity PICC on the same side presumably due to the erosion of tip of PICC out of the vein wall (not picked up in the initial X-rays). In one case, it was immediately following the starting of TPN and in remaining three it was noticed few days after starting TPN. In all these cases, the neonates started having features of respiratory distress and the diagnosis was made by radiograph of the chest. All four neonates required intercostal tube insertion and up-gradation of antibiotics. Hydrothorax resolved 48-72 h after intercostals tube insertion and removal of PICC. In these cases, PICC was reinserted at a remote site from the previous site preferably in the lower extremity. This complication was not noticed with PICC placed through femoral or popliteal veins. Swelling and erythema were seen in 7 (3.4%) and 3 (1.4%) cases respectively. Arterial cannulation occurred in 1 (2.1%), occlusion in 2 (4.2%) and dislodgement in 1 (2.1%). Complications were as shown in Table 2.

Correlation studies were done between complications and age, PICC insertion site, reason for PICC insertion and duration of PICC. No correlation was found between infective complications and age ($P = 0.40$), PICC insertion site ($P = 0.70$), reason for PICC insertion ($P = 0.40$) and duration of PICC ($P = 0.50$) as shown in Table 3.

No correlation was found between non-infective complications and age ($P = 0.30$) and reason for PICC insertion ($P = 0.40$). However, non-infective complications significantly correlated with the insertion

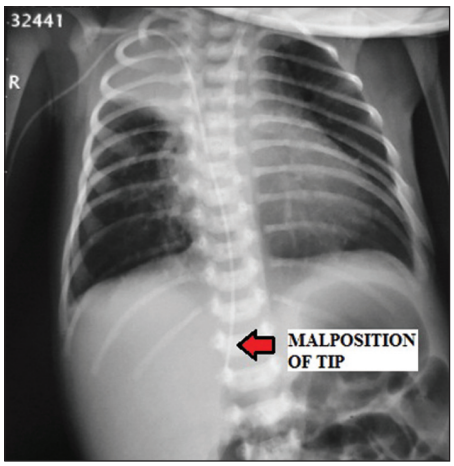


Figure 1: Malposition of the peripherally inserted central venous catheters line (pink arrow) inserted in the upper limb

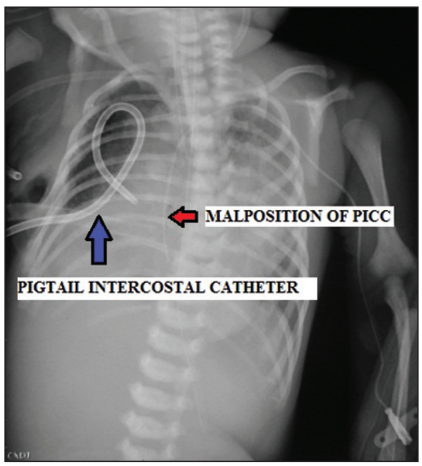


Figure 2: Pleural effusion following malposition of peripherally inserted central venous catheters line (pink arrow) managed by intercostal drain (pigtail catheter) insertion (blue arrow)

Table 2: Complications following PICC insertion

Complication	Parameters	Number (%)
Infective	Catheter related sepsis	7 (3.4)
	Sepsis	9 (9.4)
	Local wound infection	6 (2.9)
Non-infective	Malposition	11 (5.3)
	Swelling	7 (3.4)
	Erythema	3 (1.4)
	Arterial cannulation	1 (0.4)
	Occlusion	2 (0.9)
	Dislodgement	1 (0.4)
	Pleural effusion	4 (1.9)

PICC: Peripherally inserted central venous catheters

Table 3: Correlation between infective complications and various parameters

Parameters	Infective complications	*P* value
Age	—	0.40
PICC insertion site	—	
Upper extremity	—	0.70
Lower extremity	—	
Reason for PICC insertion	—	
TPN	—	0.40
Antibiotics		
Both		
Duration of PICC	—	0.50

PICC: Peripherally inserted central venous catheters

site ($P = 0.03$) and the duration of PICC ($P = 0.04$) as shown in Table 4.

DISCUSSION

Vascular access in neonates plays a pivotal role in management, but is technically challenging, especially when required for prolonged duration in surgical neonates where enteral nutrition is delayed following various surgical procedures. Since the inception of PICC, care of chronically ill-children and children in whom IV access is difficult has been revolutionised. In the early 1990s, there was a resurgence of interest in the use of PICC in an attempt to reduce the costs.[6-11] PICCs have the advantage of being placed at the bedside without general anaesthesia and remaining *in situ* for days or weeks with minimal mechanical complications. Janes *et al*. concluded that PICCs used in very-low-birth-weight infants significantly reduced IV insertions and needle punctures without adding morbidity.[12] Regardless of where and how they are placed, serious complications have been associated with the use of central catheters. In contrast to central catheters, PICC are less invasive and far less expensive and have lower morbidity and mortality.[11] They have a lower risk of morbidity at initial placement and no risk of pneumothorax and are easy to remove.[13] The advantages include elimination of catastrophic intrathoracic complications (pneumothorax and haemothorax) and significantly reduced patients cost (total health-care cost).

In our institute, more PICC have been used than CVC for long-term central venous access under the assumption that they are easy to insert, cost-effective and have a lower rate of associated morbidity. Complications associated with PICC have been extensively studied.[14,10] The overall incidence of complications varies widely among studies, ranging between 25% and 50%.[15-20] The optimal position of the PICC tip remains controversial, but the consensus on the matter is that it should rest at the junction of superior vena cava and the right atrium if inserted from superior extremity and below the level of renal veins if inserted from inferior extremity.[4] Some argue that the right atrium is a satisfactory position if the tip does not about the atrial wall or traverse the tricuspid valve or coronary sinus.[21] The tip position is traditionally assessed by a standard chest radiograph, although occasionally a second radiograph in a different position, for example right posterior oblique, is required to reduce superimposition of mediastinal structures.[22] A cadaveric study suggested that the carina is a reliable landmark to ensure extra-pericardial location of the tip.[23] Linograms or computed tomography may be used if the tip location remains in doubt.[4] Catheter tip movement following insertion is complex and dependent on multiple factors, including phase of respiration, catheter type, insertion site, body habitus and body position.[24] In the majority of patients, the tip moves caudally by at least 2 cm on arm adduction.[25] PICC tips move cranially by an average of 3.2 cm on changing position from adduction to abduction.[26] It has been suggested that PICC placed in the right arm move more than those placed in the left arm. Reported incidence of malposition of PICC without radiological guidance is approximately 10%,[27] with internal jugular vein being the most common site followed by axillary vein.[27] Malposition can trigger arrhythmias either during or after insertion.[28,29] Rarely malposition causes cardiac tamponade, which may be fatal.[30]

Table 4: Correlation between non-infective complications and various parameters

Parameters	Non-infective complications	*P* value
Age	—	0.30
PICC insertion site	—	
Upper extremity	—	0.03
Lower extremity	—	
Reason for PICC insertion	—	
TPN	—	0.40
Antibiotics		
Both		
Duration of PICC	—	0.04

PICC: Peripherally inserted central venous catheters; TPN: Total parenteral nutrition

In our study, it was observed that non-infectious complications were less in lower extremity veins as compared with the upper extremity veins [Table 4] and this difference was significant ($P = 0.03$). The duration of indwelling catheter was significantly longer in lower extremity than the upper extremity PICC [Table 1]. We also observed a significant correlation between the non-infective complications and the duration of PICC stay irrespective of the site of insertion [Table 4] suggestive of possible mechanical damage that may occur with prolonged catheter stay. Arterial cannulation has been reported in 2% of insertions, which is in consonance with our study group.[14] Other complications, such as pneumothorax, are even more rare. Cephalic vein insertion is associated with higher rates of venous thrombosis than basilic vein insertion, with thrombosis rates of 57% recorded in one American study.[31] Catheter fracture is more frequent in PICCs than CVCs.[9] It may occur during insertion, during use due to excessive syringe pressure, removal or traction on the catheter-hub junction. Success rate for PICC insertion ranges from 90% to 93%.[21] In our study group, success rate was 89%, which is comparable with other reported series. Various

complications have been described in the literature for PICC. The incidence of catheter related blood stream infection has been variably quoted from 2% to 21%.[20] In our study, the infectious complications occurred in 10.7% patients. PICC was removed in all cases and antibiotics changed as per the sensitivity pattern.

Position of PICC should be confirmed in all patients immediately following insertion and if the tip is not in the correct position it should be correctly repositioned before starting TPN. While, managing PICC one should be vigilant for possible infective and non-infective complications. Inferior extremity PICC can be preferred over superior extremity PICC. These simple precautions can thus help in preventing the morbidity associated with PICC.

CONCLUSIONS

Precautions should be taken and position must be confirmed during and after PICC insertion to avoid undue complications. There was no correlation between infective complications and age, PICC insertion site, reason for PICC insertion and duration of PICC. No correlation was found between non-infective complications and age and reason for PICC insertion, but non-infective complications significantly correlated with the insertion site and the duration of PICC.

REFERENCES

1. Chien LY, Macnab Y, Aziz K, Andrews W, McMillan DD, Lee SK, *et al*. Variations in central venous catheter-related infection risks among Canadian neonatal intensive care units. Pediatr Infect Dis J 2002;21:505-11.
2. van den Hoogen A, Brouwer MJ, Gerards LJ, Fleer A, Krediet TG. Removal of percutaneously inserted central venous catheters in neonates is associated with the occurrence of sepsis. Acta Paediatr 2008;97:1250-2.
3. Klein MD, Rood K, Graham P. Central venous catheter sepsis in surgical newborns. Pediatr Surg Int 2003;19:529-32.
4. Tan PL, Gibson M. Central venous catheters: The role of radiology. Clin Radiol 2006;61:13-22.
5. Goldstein B, Giroir B, Randolph A, International Consensus Conference on Pediatric Sepsis. International pediatric sepsis consensus conference: Definitions for sepsis and organ dysfunction in pediatrics. Pediatr Crit Care Med 2005;6:2-8.
6. Graham DR, Keldermans MM, Klemm LW, Semenza NJ, Shafer ML. Infectious complications among patients receiving home intravenous therapy with peripheral, central, or peripherally placed central venous catheters. Am J Med 1991;91:95S-100.
7. Lam S, Scannell R, Roessler D, Smith MA. Peripherally inserted central catheters in an acute-care hospital. Arch Intern Med 1994;154:1833-7.
8. Merrell SW, Peatross BG, Grossman MD, Sullivan JJ, Harker WG. Peripherally inserted central venous catheters. Low-risk alternatives for ongoing venous access. West J Med 1994;160:25-30.
9. Loughran SC, Borzatta M. Peripherally inserted central catheters: A report of 2506 catheter days. JPEN J Parenter Enteral Nutr 1995;19:133-6.
10. Cardella JF, Cardella K, Bacci N, Fox PS, Post JH. Cumulative experience with 1,273 peripherally inserted central catheters at a single institution. J Vasc Interv Radiol 1996;7:5-13.
11. Ng PK, Ault MJ, Ellrodt AG, Maldonado L. Peripherally inserted central catheters in general medicine. Mayo Clin Proc 1997;72: 225-33.
12. Janes M, Kalyn A, Pinelli J, Paes B. A randomized trial comparing peripherally inserted central venous catheters and peripheral intravenous catheters in infants with very low birth weight. J Pediatr Surg 2000;35:1040-4.
13. Parkinson R, Gandhi M, Harper J, Archibald C. Establishing an ultrasound guided peripherally inserted central catheter (PICC) insertion service. Clin Radiol 1998;53:33-6.
14. Amerasekera SS, Jones CM, Patel R, Cleasby MJ. Imaging of the complications of peripherally inserted central venous catheters. Clin Radiol 2009;64:832-40.
15. Abedin S, Kapoor G. Peripherally inserted central venous catheters are a good option for prolonged venous access in children with cancer. Pediatr Blood Cancer 2008;51:251-5.
16. Crowley JJ, Pereira JK, Harris LS, Becker CJ. Peripherally inserted central catheters: Experience in 523 children. Radiology 1997;204:617-21.
17. Matsuzaki A, Suminoe A, Koga Y, Hatano M, Hattori S, Hara T. Long-term use of peripherally inserted central venous catheters for cancer chemotherapy in children. Support Care Cancer 2006;14:153-60.
18. Thiagarajan RR, Ramamoorthy C, Gettmann T, Bratton SL. Survey of the use of peripherally inserted central venous catheters in children. Pediatrics 1997;99:E4.
19. Chait PG, Ingram J, Phillips-Gordon C, Farrell H, Kuhn C. Peripherally inserted central catheters in children. Radiology 1995;197:775-8.
20. Van Winkle P, Whiffen T, Liu IL. Experience using peripherally inserted central venous catheters for outpatient parenteral antibiotic therapy in children at a community hospital. Pediatr Infect Dis J 2008;27:1069-72.
21. Fletcher SJ, Bodenham AR. Safe placement of central venous catheters: Where should the tip of the catheter lie? Br J Anaesth 2000;85:188-91.
22. Harako ME, Nguyen TH, Cohen AJ. Optimizing the patient positioning for PICC line tip determination. Emerg Radiol 2004;10:186-9.
23. Schuster M, Nave H, Piepenbrock S, Pabst R, Panning B. The carina as a landmark in central venous catheter placement. Br J Anaesth 2000;85:192-4.
24. Vesely TM. Central venous catheter tip position: A continuing controversy. J Vasc Interv Radiol 2003;14:527-34.
25. Forauer AR, Alonzo M. Change in peripherally inserted central catheter tip position with abduction and adduction of the upper extremity. J Vasc Interv Radiol 2000;11:1315-8.
26. Kowalski CM, Kaufman JA, Rivitz SM, Geller SC, Waltman AC. Migration of central venous catheters: Implications for initial catheter tip positioning. J Vasc Interv Radiol 1997;8:443-7.
27. Trerotola SO, Thompson S, Chittams J, Vierregger KS. Analysis of tip malposition and correction in peripherally inserted central catheters placed at bedside by a dedicated nursing team. J Vasc Interv Radiol 2007;18:513-8.
28. Verdino RJ, Pacifico DS, Tracy CM. Supraventricular tachycardia precipitated by a peripherally inserted central catheter. J Electrocardiol 1996;29:69-72.
29. Bivins MH, Callahan MJ. Position-dependent ventricular tachycardia related to a peripherally inserted central catheter. Mayo Clin Proc 2000;75:414-6.
30. Orme RM, McSwiney MM, Chamberlain-Webber RF. Fatal cardiac tamponade as a result of a peripherally inserted central venous

catheter: A case report and review of the literature. Br J Anaesth 2007;99:384-8.

31. Allen AW, Megargell JL, Brown DB, Lynch FC, Singh H, Singh Y, *et al*. Venous thrombosis associated with the placement of peripherally inserted central catheters. J Vasc Interv Radiol 2000;11:1309-14.

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