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Original Article

Paediatrics Section

A Study on Peripherally Inserted Central Venous Catheter in Infants in Tertiary Care Centre

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ABSTRACT

Introduction: The survival of an increasing number of very low birth weight and critically ill neonates heightens the need for parenteral nutrition to support growth, as well as reliable vascular access for administration of additional intravenous fluids and medications.

Aim: To study the use of Peripherally Inserted Central Venous Catheter (PICC) and its complications in infants in a tertiary care centre.

Materials and Methods: It is a prospective study done in a tertiary care centre. Study period was from October 2012 to August 2014. Most of the PICC lines were inserted in preterms for Total Parenteral Nutrition (TPN) administration. Single lumen polyurethane catheter (mostly 28G) was used with breakaway needle.

Results: Total 124 PICC lines were inserted in 121 neonates. The median gestational age of insertion was 30 weeks (25-40 weeks). The median birth weight was 1060g (630-3200g). The median age for insertion in our study was 3 days (1-120 days). The most common indication for insertion of PICC line in our study was in preterm neonates for administration of TPN which was 87(70.1%), most of the PICC lines were inserted in two attempts in 75 (60.5%) neonates followed by one attempt in 35 (28.2%) neonates. Most of the PICC lines were inserted by junior residents and in long saphenous vein (91.1%).

The median catheter duration in our study was 11 days with a range of 1-35 days. Total of 37 complications were noted during 1467 catheter days with complication rate of 25.2 per 1000 catheter days. The most common complication noted was Catheter Associated Blood Stream Infection (CABSI) in 17 PICC lines (13.7%). PICC lines were electively removed after completion of therapy in 69(55.6%) neonates.

Conclusion: PICC lines are easy to insert and safe in neonates and can be safely inserted in extreme preterm neonates also. Long saphenous vein was the best site for PICC line insertion in our study. Proper and standard PICC line care can lead to less major complications.

Keywords: Complications, Safety, Total Parenteral Nutrition

INTRODUCTION

The survival of an increasing number of very-low birth weight and critically ill neonates heightens the need for parenteral nutrition to support growth, as well as reliable vascular access for administration of additional intravenous fluids and medications [1].

Previously peripheral intravenous lines or surgically placed central catheters were used in neonates requiring Total Parenteral Nutrition (TPN) [2].

Peripheral intravenous lines have a limited dwell time with infusate limit compared with other central venous catheters.

Surgical placement of central catheters is a costly procedure and can lead to complications like infection and thrombosis of vessels.

In 1973, Shaw described a technique for inserting a silicone catheter into the central veins of neonates [3-5]. Since then, the practice of inserting Peripherally Inserted Central Catheter (PICC) has been increasing because of improvements in catheter technology and insertion devices. Standard of PICC line care and maintenance has changed since then. An extensive national survey of NICU PICC practices in USA suggested that there is wide variation in multiple aspects of PICC line insertion and maintenance in different centres [6].

Hence, we have taken up this study to find out the safety of PICC lines, ease of insertion and related complications in neonates when proper maintenance and standard care protocol was followed.

MATERIALS AND METHODS

This prospective study was done in a Tertiary Care Centre NICU, Kasturba Hospital, Manipal in South India in a teaching hospital. This teaching hospital has a level 2 Neonatal Intensive Care Unit (NICU) with facilities such as radiant warmers, incubators, vital signs monitors, total parenteral nutrition facility with laminar flow, ventilators (Drager Babylog and SLE 5000), infusion pumps. All neonates with PICC lines inserted in NICU were included in the study. Study period was from October 2012 to August 2014. Approval was obtained from the Institute Ethics Committee. Informed consent was obtained from parents after explaining the procedure.

Procedure for Insertion of PICC line: The following are the indications for insertion of PICC lines:

1) Preterm neonates for TPN administration
2) Neonates with difficult venous access
3) Neonates requiring hyperosmolar solutions like high concentrated glucose
4) Neonates who had undergone surgery and requiring TPN for prolonged period
5) Neonates requiring prolonged antibiotic therapy.

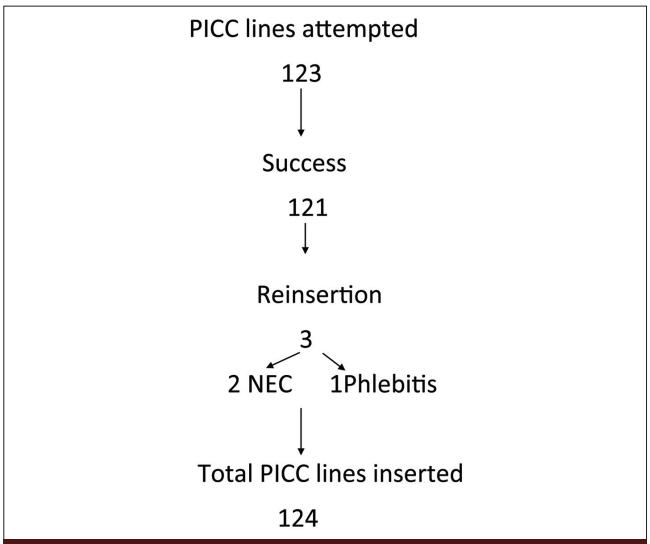
The vein to be inserted was selected, most commonly used in our study was long saphenous vein. The length to be inserted was assessed by measurements taken from the site of insertion to umbilicus for lower limb and upto the medial end of clavicle for upper limb. Single lumen polyurethane catheter was used with breakaway needle. Higher success rates were noted with polyurethane catheters in most of the earlier studies [7]. Appropriate lumen catheter size should be used [8,9]. We used 28G for preterm neonates and 24G for older neonates and infants. After hand wash, sterile gown and gloves were donned. The insertion site and surrounding skin along the course of vein was cleaned thoroughly with 2% chlorhexidine. Sterile towel was draped underneath and above the insertion site. Hepsaline was prepared with 1U/1ml of heparin. The catheter was flushed with Hepsaline. First the introducer was inserted into the vein and after blood return, the catheter was advanced slowly through the introducer using forceps. After inserting the measured length of catheter the needle was taken out. The catheter was secured with transparent dressing (Tegaderm). Tip position was confirmed by check X-ray whether it was in superior vena cava/inferior vena cava. The PICC line was pulled out few centimetres if the tip was found to be in right atrium. Repeat check X-ray was taken. The tip of the PICC line should be in superior vena cava for upper extremity and in thoracic inferior vena cava for lower extremity insertions [10,11]. After confirming the position IV fluids were started. Documentation of procedure was done.

DATA COLLECTION

After insertion of PICC lines during the study period, data was collected regarding the gestational age of neonates, birth weight, indication for insertion, post natal day of insertion, date of insertion and date of removal, site of insertion , tip position on X-ray, ease of insertion, catheter days, complications and indications for removal.

RESULTS

PICC line insertion was attempted in 123 neonates and successfully inserted in 121 neonates during the study period from October 2012- August 2014. Total 124 PICC lines were inserted in 121 neonates. PICC line was inserted for second time in three neonates. Two neonates developed Necrotising Enterocolitis (NEC) after first PICC line was removed hence second PICC line was inserted for administration of TPN. Third neonate developed phlebitis warranting removal of PICC line and reinsertion of another PICC line for continuation of therapy [Table/Fig-1].



[Table/Fig-1]: PICC line insertion chart.

The median gestational age of insertion was 30 weeks (25-40 weeks). The median birth weight was 1060 g (630-3200 g) [Table/Fig-2]. The median age for insertion in our study was three days (1-120 days). In one of the study infants PICC line was inserted at four months of age for difficult IV access and prolonged antibiotic therapy for cerebral abscess. PICC line was inserted after 20 days of postnatal age in 10 neonates. Of these 10 neonates five had meningitis hence PICC lines were inserted for difficult IV access and continuation of antibiotic therapy, three PICC lines were inserted in neonates with Hypoxic Ischemic Encephalopathy (HIE) and seizures with difficult IV access, one neonate had Congenital Adrenal Hyperplasia (CAH) and hyponatremia requiring IV fluids with difficult IV access and one

Neonatal Characteristics	n=121(%)
Gestational Age (weeks)	
25-30	66(54.5)
31-35	33(27.3)
36-40	22(18.2)
Gender	
Male	55(45.5)
Female	66(54.5)
Birth Weight (grams)	
600-1000	53(43.8)
1001-1500	42(34.7)
1501-2000	5(4.1)
2001-2500	12(9.9)
2501-3000	8(6.6)
>3000	1(0.9)

[Table/Fig-2]: Baseline characteristics of neonates with PICC lines.

neonate for administration of Total Parenteral Nutrition (TPN) following surgery.

The most common indication for insertion of PICC line in our study was in preterm neonates for administration of TPN which was 87(70.1%), followed by for difficult venous access in 14(11.3%) neonates ,after surgery for TPN administration in 12(9.7%) neonates, for prolonged antibiotic administration in 5 (4%) neonates , post NEC for TPN administration in 5(4%) neonates and for infusion of high concentrated glucose in 1(0.9%) neonate. During the study period two failures at insertion were noted with success rate of insertion of 98.4%.Most of the PICC lines were inserted in two attempts in 75(60.5%) neonates followed by one attempt in 35 (28.2%) neonates. Most of the PICC lines were inserted by junior residents out of which 21 were by first attempt and 46 were inserted by second attempt.

In this study most of the catheter tips 113(91.1%) were in either superior vena cava or inferior vena cava [Table/Fig-3]. In the present study 5(4%) PICC line tips were noted in right atrium which was pulled out by few centimetres. Most of the PICC lines were inserted in long saphenous vein (91.1%). We did not put any PICC line in scalp vein, one of the recent study showed PICC line in scalp veins are not associated with major complication [12]. In this study one of the PICC lines had tip in peripheral vein of opposite limb which was removed because if the tip is in peripheral vein the risk of thrombosis and phlebitis is high.

Catheter Tip Position	Upper Limb (11)	Lower Limb (113)
Inferior Vena Cava	-	104
Superior Vena Cava	9	-
Right Atrium	2	3
At Saphenofemoral Junction	-	4
Peripheral Vein of Same Limb	-	1
Peripheral Vein of Opposite Limb	-	1

[Table/Fig-3]: Catheter tip position on X-ray (n=124).

The median catheter duration in our study was 11 days with a range of 1-35 days [Table/Fig-4].Total of 37 complications were noted during 1467 catheter days with complication rate of 25.2 per 1000 catheter days. The most common complication noted was Catheter Associated Blood Stream Infection (CABSI) in 17 PICC lines (13.7%) followed by phlebitis in 14 PICC lines (11.3%) .The infection rate was 11.4 per 1000 catheter days [Table/Fig-5].

Catheter Dwell Time (days)	n=124(%)
1-5	26(20.9)
6-10	32(25.8)
11-15	39(31.5)
16-20	14(11.3)
21-25	6(4.8)
26-30	4(3.2)
31-35	3(2.5)

[Table/Fig-4]: Catheter dwell time (n=124).
124 catheters were placed over 1467 catheter days.

Complication	n=37 (%)
Catheter associated Blood Stream Infection (CABSI)	17 (13.7)
Phlebitis	14 (11.3)
Occlusion	3 (2.4)
Catheter Break	1 (0.9)
Edema of Lower Limb and Abdomen	1 (0.9)
Subcutaneous Tracking over the Abdomen	1 (0.9)

[Table/Fig-5]: Complications noted during the study period.

[Table/Fig-6]: Catheter breakage in lower extremity.

[Table/Fig-7]: Picture of PICC line tracking over abdomen. **[Table/Fig-8]:** Catheter at saphenofemoral junction. **[Table/Fig-9]:** Catheter with loop at saphenofemoral junction (from left to right).

Most common oraganism grown was *Klebsiella* (9), *Enterobacter* (2), *Acinetobacter* (2), *Pseudomonas* (1), *Candida* (1), *E.coli* (1), *Serratia* (1).

One catheter break was noted during removal of catheter. The proximal tip was found in femoral vein on USG abdomen and removed surgically [Table/Fig-6].

In one of the neonates, tip was found to be in IVC but after starting IV fluid infusion subcutaneous tracking was noted over the abdomen and hence removed [Table/Fig-7].

In another neonate PICC line was removed due to abdominal wall edema. One of the PICC lines was in saphenofemoral junction [Table/Fig-8] and one PICC line X-ray revealed loop at saphenofemoral junction [Table/Fig-9].

Total 17(13.7%) complications were noted in neonates with birth weight of 600-1000 g. 13 (10.4%) complications were noted in neonates with birth weight of 1001-1500g and 3 (2.4%) complications in neonates with birth weight of 1501-2000 g, 3(2.4%) complications in neonates with birth weight of 2001-2500 g, 1(0.9%) complication in neonate with birth weight of 2500-3000 g. There was no relationship between birth weight and catheter complications.

PICC lines were electively removed after completion of therapy in 69(55.6%) neonates, 25(20.1%) PICC lines were removed due to complications, 20(16.2%) PICC lines were removed after death, 6 PICC lines were removed prematurely due to Discharge Against Medical Advice (DAMA) which was 4.8% and 3(2.4%) due to accidental dislodgement, 1(0.9%) PICC line was removed due to malposition in peripheral vein of opposite limb.

Of 20 neonates that succumbed, 14 neonates were between 25-30 weeks with birth weight less than 1000g. Eight neonates succumbed due to sepsis and related complications, four neonates died due to severe Respiratory Distress Syndrome (RDS), four succumbed due to Intraventricular Haemorrhage (IVH), two neonates died due to severe pulmonary haemorrhage, one neonate succumbed due to bilateral pneumothorax and one neonate had Hypoxic Ischaemic Encephalopathy (HIE)with aspiration pneumonia.

Of six neonates with DAMA, two neonates were preterm with Severe RDS, one preterm neonate with sepsis and NEC, one of the neonate was preterm with Ileal atresia, one neonate had tracheo-esophageal fistula and imperforate anus and one neonate had Waardenburg's syndrome, Hirschsprung disease and sepsis.

DISCUSSION

The median gestational age of insertion noted in our study was 30 weeks (25-40 weeks) whereas, in other studies was from 28 -30 weeks [13,14]. The median birth weight in a study by Hoang V et al., [14] was 940 g which was lower than the present study (1060 g). In one more study by Neubaeuer et al., the median birth weight was 1330g [13]. Median age of insertion in our study was three days (1-120 days).

Hoang V et al., [14] compared lower limb vs. upper limb insertion for TPN and found that lower limb PICC lines had lower CABSI, longer time to first complication and lower cholestasis hence they suggested that lower extremity PICC lines should be inserted for TPN. Another study also did not find any significant difference between upper limbs versus lower limb PICC line insertion [15]. In this study, we could not compare lower limb vs. upper limb PICC line insertion since majority of PICC lines were inserted in lower extremity. Long saphenous vein becomes prominently visible by day 2 of life in extremely premature babies once the oedema subsides hence the bias for lower extremity PICC line in our study.

In other studies the success rate of insertion varied from 88-95% [14,16].

In a study by Neubauer et al., [13] the median age of insertion was 4.6 days. In a study by Hoang V et al., [14] the median age of insertion was 6.4 days.

In a study by Uygun I et al., the most common indication for PICC line insertion was for securing IV access (53%), antibiotics

(25%), TPN (12%), irritant agents (3%). Also (n=42) PICC line insertion success rate was 95% and success rate at first attempt was 86% [17].

In the study by Neubauer et al., [13] the success rate at first attempt was 63.6%. In a study by Njere I et al., [18] the success rate at first attempt was 71%, two attempts -21% , three attempts-6%, four attempts - 2%.

In the study by Uygun I et al., [17] the PICC line tip was central in position in 100% and most commonly used vein was long saphenous vein (85%). Evans M et al., [2] reported 95% of catheter tips in central position. Njere I et al., [18] reported 72.8% PICC line tips in central position.

It is important to locate the PICC line tip following insertion by X-ray or ultrasound, this prevents complications like pericardial effusion. In the present study 5 PICC line tips were in right atrium noted by X-ray and was subsequently pulled out. There was no incidence of pericardial effusion in the present study. In a study by Hoang V et al., [14] the median catheter duration was 13 days (8-22 days). Neubauer et al., [13] reported the median catheter duration of 22 days. Cartwright D [16] reported median duration of 14 days (1-99 days). In a study by Evans M et al., [2] the median duration was 19 days.

Many studies reported complication rate of 1.1-19.3 per 1000 catheter days with infection rate of 0.2-6.4 per 1000 catheter days [13,14].

Some studies reported infection rate of 12-15.1% [1]. Njere I et al., [18] reported infection rate of 17 per 1000 catheter days. Cartwright D [16] reported a complication rate of 11 per 1000 catheter days with 3.2 infection rate per 1000 catheter days. Evans M et al., [2] reported complication rate of 15 per 1000 catheter days with 3.6 infection rate. Most of the studies reported most common infection as Coagulase negative *Staphylococcus* [14,18,19]. Hoang V et al., [14] reported more infection in upper extremity PICC lines than lower extremity. However, in the present study 17 neonates had positive blood culture, *Klebsiella* was the most common organism grown. Ike Njere et al., [18] found significant relation between duration of catheter stay and infection however in this study we did not find any relation between length of catheter stay and infection.

Uygun I et al., [17] reported elective removal in 65%, after death-22%, complications 13%. Cartwright D [16] reported elective removal of 69.7%, death (6.5%), incorrect position (0.5%), complications (23.3%). Evans M [2] reported elective removal of 41.4%. Njere I et al., [18] reported elective removal of 53.7%, complications-36.9%, abnormal position-1.4%, after death-1%.

LIMITATIONS

Apart from small sample size, comparison between upper limb and lower limb was not done since we chose long saphenous vein in most of the neonates and also did not insert PICC line in any scalp vein, which all are the limitations of our study.

CONCLUSION

PICC lines are easy to insert and safe in neonates including extreme preterms. Long saphenous vein is the best vein for insertion of PICC line in neonates especially preterm babies. Standard protocols for PICC line care if followed may lead to less major complication.

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