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Original Article

Percutaneous cannulation of central veins in neonates: Its safety and feasibility: Audit of 75 neonatal insertions

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Abstract

Introduction: Central venous catheters (CVC) have become an integral part in the care of children in intensive care settings. However, their use in neonates is limited due to inherent difficulties in insertion and associated complications. **Objective:** We present our experience in the use of CVC by percutaneous cannulation in neonates. **Materials and Methods:** A total of 75 cases of neonatal percutaneous central venous cannulation inserted over a period of 6-month from March 2014 to August 2014. Data regarding age, indication for central line insertion, site of insertion, complications related to central line insertion, duration of catheter days, were collected. **Results:** Of the 75 neonates, 49 were male and 26 were female. Age group ranged from 14 to 30 days with a median of 21 days. Weight ranged from 750 g to 3.5 kg with an average of 1.9 kg. The internal jugular vein was accessed in 45 (60%), followed by femoral 26 (34.6%) and subclavian in 4 (5.3%) cases. Successful percutaneous cannulation was achieved in all and the median catheter days were 12 days. The longest catheter patency was 46 days in one neonate. The most common indication for placement was failure of peripheral venous access (78%). The main complications encountered were catheter displacement (12%) and catheter malposition (9.3%). Catheter induced sepsis was seen in 7 (9.3%) neonates. **Conclusion:** Percutaneous cannulation of central veins in neonates is feasible, and safe, with acceptable morbidity. Ultrasound guided central line insertions is becoming the gold standard in neonates, as the entire vascular anatomy is delineated and variations in anatomy clearly identified; hence avoiding multiple attempts and complications. Contrast injected X-rays confirmation even when the catheter is radio-opaque is effective in accurate tip identification and helps in preventing tip related complications.

Key words: *Neonates, central venous catheters, percutaneous, cannulations, ultrasound guided*

Central venous catheters (CVC) have become an integral part in the care of children in intensive care unit (ICU) settings. However, their use in neonates is limited due to inherent difficulties in insertion and associated complications. Several studies [1-3] have confirmed the safety of central catheters in the neonate. Still, an open "cut down" approach is utilized in many parts of the world which can be avoided. We present our experience in percutaneous cannulation of central veins in neonates. The objectives of our study were to study the indications, technical difficulties, and complications related to the use of central lines in neonates.

MATERIALS AND METHODS

A total of 75 cases of neonatal percutaneous central venous cannulation inserted over a period of 6-month from March 2014 to August 2014 were included in this study. Umbilical venous catheterization and peripherally inserted central catheters were not included in our study. Various parameters including the age and sex of the baby, indication for central line insertion, site of insertion, complications related to central line insertion, duration of catheter stay, whether the intended reason for cannulation was fulfilled were assessed. Written informed consent was taken from the parents before insertion after explaining in detail regarding the advantages, cost factors, and complications involved.

Strict adherence to insertion protocols was followed. All cannulation were done under adequate sedation with midazolam. Strict, standard aseptic precautions were taken in all cases before cannulation. In babies, who did not have previous blood culture sensitivity, blood was taken at the time of cannulation. However, in neonates who were already in sepsis (documented by previous blood c/s) and were on antibiotic coverage, samples were not sent.

All the catheters were inserted by standard Seldinger's technique. Single lumen with a length of 5 cm and 22 G catheters were used. Percutaneous needle puncture of the vein was done, through which a guidewire was passed. The tract was dilated using a dilator. The needle was removed and the catheter was

threaded over the guidewire. The guide wire was removed and catheter fixation was done. The position of the catheter tip was confirmed by X-ray, which was done in all cases (Fig. 1). The expected position was between superior vena cava and right atrial junction. In the case of any malposition, the catheter was suitably adjusted later. In the latter half of study, the catheter tip position was re-confirmed by injecting 1:1 dilution of urograffin contrast dye through the catheter while taking check X-rays for better visualization. In the last 15 neonates, we had access to ultrasound for guidance for insertion of the catheter. This helped us in minimizing the number of attempts and clear definition of the venous anatomy (Fig. 2). The ultrasound technique was performed with the aid of a portable ultrasound device (8 MHz transducer, Vivid i General Electric®, Horten city, Norway) covered by a sterile sheath and gel.

Catheter care was reinforced to all neonatal ICU nurses. Strict asepsis while handling the catheters was emphasized. Single lumen catheters were preferred unless specifically indicated. Regular periodic flushing of the catheters with heparinized saline was done. Daily inspection of the catheter dressing was done for the assessment of soakage or displacement of the catheter. New onset of sepsis following catheter insertion was documented. The total time duration required for insertion,

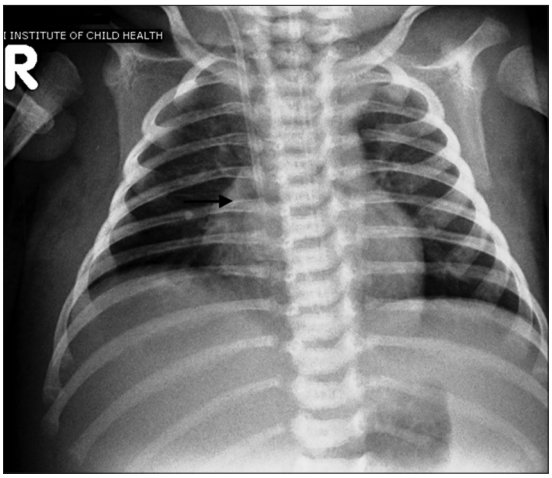

Figure 1: Chest X-ray confirming the exact position of catheter tip

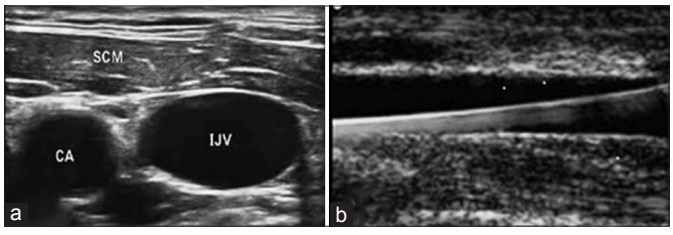

Figure 2: (a) Ultrasound image showing the position of internal jugular vein and carotid artery, (b) post central line insertion, ultrasound image showing the normal lie of the catheter in the internal jugular vein lumen. (SCM- sternocleidomastoid muscle, CA - carotid Artery, IJV - internal jugular vein)

the number of attempts and any complications noticed during insertion including arterial cannulation, pneumothorax, and hemothorax were documented.

The total number of days for which the catheter was used and the indication for removal was noted. At removal, all catheter tips were sent for culture sensitivity. Catheter induced sepsis was considered if an aseptic child developed sepsis following insertion and both blood culture sensitivity and catheter tip culture sensitivity grew the same organism. A pre-formed proforma was used to document all data during insertion and follow-up period. Complications were classified into procedural, early - occurring within 48 h and late - occurring after 48 h.

RESULTS

Successful percutaneous cannulation was achieved in all 75 neonates including 49 (65.3%) males and 26 (34.6%) females. Age group ranged from 14 to 30 days with a median of 21 days. Weight ranged from 750 g to 3.5 kg with a median of 1.9 kg. 24(32%) of the neonates included were pre mature and weighed <1.5 kg as shown in Table 1.

The main site of venous access was internal jugular vein (IJV) in 45 (60%) cases, followed by femoral vein in 26 (34.6%) and subclavian vein in 4 (5.3%) cases. Most of the internal jugular cannulation were on the right side (90%). The median catheter days were 12 days. The longest catheter patency was 46 days in one child. The most common indication for placement was failure of peripheral venous access (78%), followed by parenteral nutrition in 16% and shock resuscitation in 5%. In last 15 neonates, ultrasound guidance was used for percutaneous line cannulation. In 13 out of 15 patients where ultrasound guidance was used, vein was punctured in the first attempt.

Our overall complication rate was 40% of which 30.6% were due to malposition or displacement. These were corrected immediately following x-ray imaging and reconfirmed on X-ray before utilization (Table 2). In the majority of the cases, the catheter was lowly placed in the right atrium, which needed to be pulled out and repositioned. We had 2 (2.66%) procedural

Table 1: CVL inserted during the study period - weight distribution

Total neonatal insertion	75
750 g birth weight	02
750-999 g birth weight	16
1000-1499 g birth weight	24
1500-2500 g birth weight	22
>2500 g birth weight	11
Duration of CVL (days)	12 (2-46)

CVL: Central venous line

complications as two neonates developed hemothorax (Fig. 3) due to inadvertent placement of the catheter in the pleural cavity, which was successfully treated with ICD insertion, drainage and blood transfusion.

Late complications included catheter sepsis and blockage of the catheter. Catheter induced sepsis was seen in 7 (9.3%) neonates, the most common organism being Coagulase negative *Staphylococcal aureus* (50.9%). Candida infection was seen in 2% of the neonates. The catheters were removed on confirmation of infection, and the catheter tip was sent for culture and sensitivity. The neonates received culture specific IV antibiotics. The neonates showing fungal infection received Amphotericin-B. Blocked catheters, which were not relieved on flushing with heparin solution, were also removed. Various causes for central line removal were noted with the duration of central line usage as shown in Table 3.

DISCUSSION

CVCs are widely used in children for various reasons including shock resuscitation, administration of parenteral nutrition, failure of access to peripheral lines, etc. Percutaneous cannulation is the most preferred technique, especially in older children. However, their use in neonates is limited due to inherent difficulties in insertion and associated complications. Central venous cannulation offers distinct advantage to the neonates in terms of repeated blood samplings, administration of hyperosmolar solutions, during resuscitation of shock where multiple drugs may need to be given simultaneously and avoidance of multiple pricks in cases of difficult venous access.

Most commonly used veins for central vascular access include internal jugular, femoral, and subclavian veins. Right IJV is preferred to the left since it has a much straighter course. The technique of insertion is presently well standardized [1]. Selecting the proper size and length of the catheter is of primary importance since it helps in preventing avoidable complications. Large series from Royal Brisbane Hospital (RBH), Australia have confirmed the safety of these catheters and emphasized the importance of strict insertion and management principles [2]. It was seen that catheters with their tips in the right atrium and not coiled did not cause pericardial effusion. The incidence of malposition was higher in our series (9.3%) perhaps owing to consideration of catheter tip in the right atrium as malpositioned, while in RBH series, catheter tips placed in the right atrium and uncoiled was considered as normally placed (Table 4).

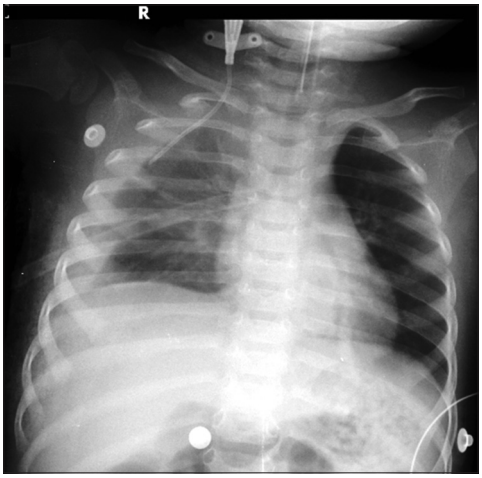

Figure 3: Chest X-ray showing malpositioned catheter with hemothorax

Catheter induced sepsis rates were slightly higher in our series (9.3% vs. 5.3%); though, the organisms causing infection were almost similar indicating that our catheter care needs to be improved. The increased incidence of catheter-related sepsis is also contributed by poor nurse-neonate ratio (1:5), increasing the cross contamination risk. Catheter-related infections vary from 0-46% in various reports [3,4]. There are reports of the use of fluconazole to reduce fungal colonization and septicemia in extremely low birth weight

Table 2: Various complications observed during the study period (%)

Catheter malposition	7 (9.3)
Catheter induced sepsis	7 (9.3) 50.9 Cons 2 Candida
Catheter blockage/leakage	5 (6.6)
Catheter displacement	9 (12)
Hemothorax	2 (2.6)

Table 3: Reasons for CVL removal (%)

Completion of treatment	51 (68)
Septicemia	6 (8)
Catheter block/leakage/bleeding	7 (9.33)
Line accidents	3 (4)
Death during CVL usage (other causes)	8 (10.66)

CVL: Central venous line

Table 4: Comparison of our complications with RBH series

Parameters	RBH (%)	IGICH (%)
Malposition	10 (0.5)	7 (9.3)
Catheter induced sepsis	116 (5.3) −24.3 - Cons −0.23 - Candida	7 (9.3) −50.9 - Cons −2 Candida
Catheter blockage/ leakage	97 (4.4)	5 (6.6)
Displacement		9 (12)
Hemothorax		2 (2.6)

RBH: Royal Brisbane Hospital, IGICH: Indira Gandhi Institute of Child Health

babies with CVCs [5]. Candida septicemia has been very uncommon since the introduction of fungal prophylaxis. A multicenter trial proved the efficacy of prophylactic use of oral nystatin and fluconazole in very low birth neonates (<1500 g) in preventing the incidence of invasive fungal infections [6].

Our catheter blockage/leakage rates were less than RBH series owing to the preferential use of single lumen catheters unless specifically asked for. Due to increased incidence of catheter malposition and displacements, we started to check the position of catheter tip with contrast X-rays in the later part of the study. Contrast study was not only effective in correctly identifying the catheter tip and thus helping in repositioning the catheter. Some Authors have advised continuous contrast injection during X-ray exposure, leaving a blush of contrast at the catheter tip. This simple step help in ensuring exact position of catheter tip [7].

Contrast injection can also alert to abdominal wall vein positioning (following femoral access), which may lead to hypoglycemia and an incorrect diagnosis of necrotizing enterocolitis [8]. Catheters in the ascending lumbar vein have been associated with serious morbidity and mortality [9,10] but are easily identified by contrast injection. There are also reported the use of digital computed radiography with excellent enhancement and localization of catheter tip [11]. The ultrasound guided technique is becoming the gold standard for IJV catheterization because it can both increase the success rate and decrease the complications [12,13]. Since 2002, the National Institute for Clinical Excellence has recommended the use of ultrasound guidance as the preferred method for IJV catheterization in children [14].

A number of studies have suggested that an increase in the number of insertion attempts is associated with higher complication rate. McGee and Gould [15] reviewed CVC complications and found that the incidence of mechanical complications after 3 or more insertion attempts was 6 times the rate after one attempt. Asheim et al., [16] found that the vein was punctured during the first attempt in 40 out of 42 patients during ultrasound guided CVC placement. Significant reduction in cannulation time and higher success rates have been seen in ultrasound guided techniques in comparison to landmark techniques [17-19]. Ultrasound guidance also reduced complications due to faster access.

CONCLUSION

Percutaneous cannulation of central veins in neonates is feasible, safe, with acceptable morbidity. Ultrasound guided central line insertion is becoming the gold standard in neonates, as the entire vascular anatomy is delineated and variations can be clearly identified; hence avoiding multiple attempts and complications.

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