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Role of Ultrsonography in Detecting the Location of Tip of Percutaneous Central Venous Catheters in Neonates at Hi-Tech Medical College and Hospital, Bhubaneswar

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Abstract:-

<u>Background:-</u> In most of the neonatal intensive care unit (NICU) percutaneous central venous catheters (PCVCs) are mostly used for supplementation of fluid, medication and parenteral nutrition administration. In India most of the NICUs routinely use conventional chest abdomen radiography (CXR) procedure for detecting the position of tip of PCVCs. Real-time ultrasonography (RTUS) at bedside for procedural guidance has seen increased use in pediatric emergency medicine and pediatric critical care to reduce procedural time and burden, decrease radiation exposure, and minimize potential complications. There are certain life threatening complications such as pleural effusion, pericardial effusion and cardiac tamponade associated with insertion of PCVCs in upper extremities in comparison to PCVCs inserted in lower extremities. Therefore in this study we had opted insertion of PCVCs in lower extremities.

<u>Methods:-</u> The study is a prospective cohort study, done in NICU at Hi-Tech medical college and hospital, Bhubaneswar from August 2019 to December 2020 in the neonatal patients who needed and received PCVC insertion in their lower extremities. The data of neonatal patients who received PCVC insertion from June 2018 to July 2019 and whose catheter tip location was confirmed by CXR only were also included and reviewed retrospectively. All neonates who received PCVC from 2018 to 2020 were divided into 2 groups named as Ultrasonography group (USG group) and Conventional chest abdomen radiography group (CXR group). In USG group the tip locations of the PCVCs were evaluated by USG and confirmed by CXR and in CXR group it was confirmed by CXR only. The neonatal patients gestational age, post-menstrual age, gender, birth weight and body weight on the procedure date along with the withdrawal rate and duration of tip confirmation was noted. Complications of PCVC insertion like phlebitis, leakage, occlusion and catheter related infection were also noted.

<u>Result:-</u> There were total 165 PCVCs inserted from June 2018 to December 2020 in both the groups. In USG group 90 PCVCs were inserted in 73 neonates with median gestational age of 32.30 weeks. In CXR group 75 PCVCs were inserted in 62 neonates with median gestational age of 32.90 weeks. In both the groups no significant differences in demograhic and complication data of PCVC insertion were noted. The withdrawal rate was comparatively higher in CXR group (69.10%) than in USG group(14.70%). Time required for confirmation of the tip of catheter in CXR group was 60min - 240min which was significantly shorter in USG group 3min - 5min (P<0.001).

<u>Conclusion:-</u>This study suggests that USG should be a replacement to routine CXR for confirmation of tip location of PCVCs as USG is convenient and accurate tool for confirming tip location and also RTUS guidance minimize the risk of complication due to line malposition.

***Keywords**:- Neonate, Ultrasonography, Catheter, Complication.*

I. INTRODUCTION

In most of the neonatal intensive care unit (NICU) percutaneous central venous catheters (PCVCs) are mostly used for supplementation of fluid, medication and parenteral nutrition administration. PCVCs are preferable and superior to peripheral intravenous catheters in the neonates as they do not need frequent replacement and can tolerate hypertonic fluid.[1] There were no evidence found mentioning that use of PCVC increases risk of systemic infection.[2] PCVCs need to be inserted by well-trained operators via a peripheral vein with the tip placed in a central vein. Misplaced PCVC tips may induce life-threatening complications and prolong hospitalization.[3,4]

In India most of the NICUs routinely use conventional chest abdomen radiography (CXR) procedure for detecting the position of tip of PCVCs. However, CXRs are not accurate in ascertaining the catheter tip position (CTP) as the precise relation of the tip to vascular anatomic landmarks is not obtainable but instead inferred by its relation to the bony vertebral column and/or liver and diaphragm.[5,6] In addition the disadvantages of CXR includes radiation exposure, inability to provide real time assessment and manually positioning of neonates which is against the protocol of minimal touch of neonates. Studies have revealed that ultrasonography (USG) provides a real-time view by which the operators can assess the tip location and withdraw the PCVC tip when necessary compared to conventional radiography alone in neonates.[7,8] Real-time ultrasonography (RTUS) at bedside for procedural guidance has seen increased use in pediatric emergency medicine and pediatric critical care to reduce procedural time and burden, decrease radiation exposure, and minimize potential complications.[9-11]Apart from this USG also helps in confirming the location of tip of umblical vein catheter, umblical artery catheter, peripherally inserted central catheter and other catheters which are commonly used in neonates in NICU.

There are certain life threatening complications such as pleural effusion, pericardial effusion and cardiac tamponade associated with insertion of PCVCs in upper extremities in comparision to PCVCs inserted in lower extremities.[3,4]Along with this, it is also difficult to assess the position of tip in superior venacava in premature neonates because of the presence of endotracheal tube or nasogastric tube. Therefore in this study we had opted insertion of PCVCs in lower extremities. As very small number of cases require this procedure and with lack of sufficient evidence, we could not support the use of USG as the Gold standard tool for detecting the location of tip of PCVCs.

II. AIM AND OBJECTIVE

1. This study was designed to assess the role of USG for inserting PCVCs in the lower extremities in neonates.
2. To identify the appropriate tool for confirmation of PCVC tip position.

III. METHODS

The study is a prospective cohort study, done in neonatal patients of NICU at Hi-Tech medical college and hospital Bhubaneswar. The study period was from August 2019 to December 2020 and the neonatal patients who needed and received PCVC insertion in their lower extremities were taken for the study after informed parental consent. The data of neonatal patients who received PCVC insertion from June 2018 to July 2019 and whose catheter tip location was confirmed by CXR only were also included and reviewed retrospectively and the duration required for CXR procedure and reporting for this patients was also noted from their files. The neonatal patients gestational age (GA), post-menstrual age (PMA), gender, birth weight and body weight on the procedure date along with the the rate of PCVCs withdrawal and duration of tip confirmation was also noted. Complications of PCVC insertion like phlebitis, leakage, occlusion and catheter related infection were also noted. All neonates who received PCVC from 2018 to 2020 were divided into 2 groups named as Ultrasonography group (USG group) and Conventional chest abdomen radiography group (CXR group). The neonatal patient in USG group had the PCVCs whose tip locations were evaluated and confirmed by USG. All USG evaluation was done by the same neonatologist for the accuracy of the view and the reporting of CXR was done by different neonatologist who was blindfolded to the USG findings. The neonatal patient in CXR group had the PCVCs whose tip location was confirmed by CXR only.

The PCVCs were inserted by a specific team which had one neonatalogist, one nurse and one post graduation trainee. Every time the PCVCs were inserted by the same team under sterile conditions. The PCVCs used were 2.0 French single lumen catheter and the ultrasound machine used was Philips ultrasound machine (USA) with a sector probe having frequency range of 5-12 Hz. The estimation of the length of insertion was based on the site of the insertion. After the insertion of PCVC the USG was done by the neonatologist using the sector probe in subcostal view to assess the tip location before removing the guide wire. Whenever there was any misplacement or malpositioned tip it was adjusted under real time dynamic view of USG. The tip of the PCVC should be visualized in the inferior venacava and close to right atrium. CXR were done as per the unit's routine practice with proper positioning for all study neonates to reconfirm the location of the tip. Ohki et al were able to visualize the tips of even very thin central catheter by USG and also were able to detect line dislodgement from postural changes.[8] Michel et al found that the sensitivity and specificity were, respectively, 93.3 and 95.6% for USG and 66.7 and 63.0% for CXR in determining the tip of Umblical Venous Catheters after insertion.[12] Post insertion utility of US for repositioning and preventing potential complications have been well documented.[12-14] Four time points were recorded throughout the procedure:- a) at the beginning of USG evaluation (on appearance of the image in the monitor after the probe was put on the chest wall), b) at the end of USG evaluation (on confirmation of tip location), c) prescribing for CXR and d) confirmation of tip after evaluation of radiographic film. The results of the CXR were compared in both the groups.

IV. STATISTICAL ANALYSIS

The neonatal patients gestational age, post-menstrual age, gender, birth weight and body weight on the procedure date, the rate of PCVCs withdrawal and duration for tip confirmation were compared by Manne Whitney U test for continuous variables after Shapiroe Wilk test indicated non-normality of the data. Chi-square test was used for categorical data between the sono and non-sono groups. All tests were 2-tailed and P value < 0.05 was considered statistically significant. All statistical analyses were performed by IBM SPSS 23 statistics software (IBM Corp., Armonk, NY, USA).

V. RESULTS

There were total 165 PCVCs inserted from June 2018 to December 2020 in both the groups (Fig.1). In USG group (Aug-19 to Dec-2020) 90 PCVCs were inserted in 73 neonates as 17 neonates needed second PCVC insertion due to infection, occlusion, prolonged catheterisation and phlebitis for more than 4 weeks. Among 73 neonates in

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USG group 15 were full term and 58 were preterm neonates with median gestational age of 32.30 weeks. In CXR group (June18 to July-19) 75 PCVCs were inserted in 62 neonates as 13 needed second PCVC insertion. Among 62 neonates 12 were full term and 50 were preterm neonates with median gestational age of 32.90 weeks.

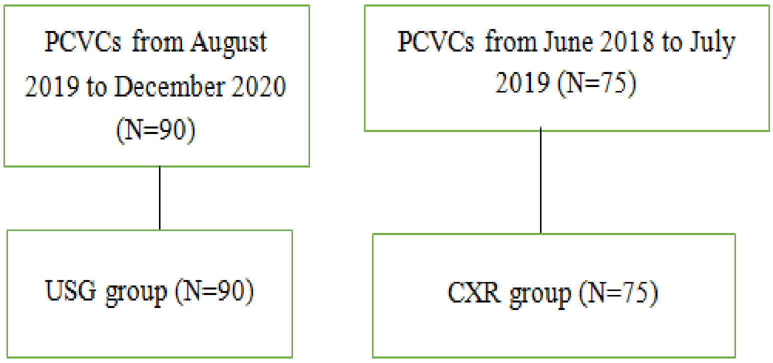

Fig.1 Flow chart of enrollment and grouping.

In both the groups with respect to gestational age, post-menstrual age, gender, birth weight and body weight on the procedure date, no markable differences were seen. No significant differences on complications of PCVC insertion like phlebitis, leakage, occlusion and catheter related infection were also noted. The withdrawal rate was comparatively higher in CXR group (69.10%) than in USG group(14.70%). Time required for confirmation of the tip of catheter in CXR group was 60min - 240min which was significantly shorter in USG group 3min - 5min (P<0.001) as presented in Table 1.

	USG group (n=90)	**CXR group (n=75)**	**P value**
Gender (Male/Female)	50/40	40/35	
Gestational age (wk)	32.30 (28.50-36.30)	32.90 (28.25-36.60)	
Birth weight (g)	1420 (950-2400)	1450 (925-2450)	
Post menstrual age on procedure date (wk)	33.50 (30-38.20)	33.70 (30.10-37.90)	
Body weight on procedure date (g)	1520 (1120-2550)	1500 (1090-2500)	
Occlusion (n, %)	9, 10%	8, 10.66%	
Phlebitis (n, %)	3, 3.3%	4, 5.3%	
Leakage	4, 4.4%	3, 4%	
Catheter related infection	5, 5.5%	5, 6.6%	
Withdrawal rate (%)	14.70	69.10	<0.001
Duration for tip confirmation (min)	4.0 (3-5)	150 (60-240)	<0.001

Table 1. Demographic and complication data between CXR and USG groups.

The pictures of the tip locations of PCVCs detected by CXR and USG are shown in Fig. 2.

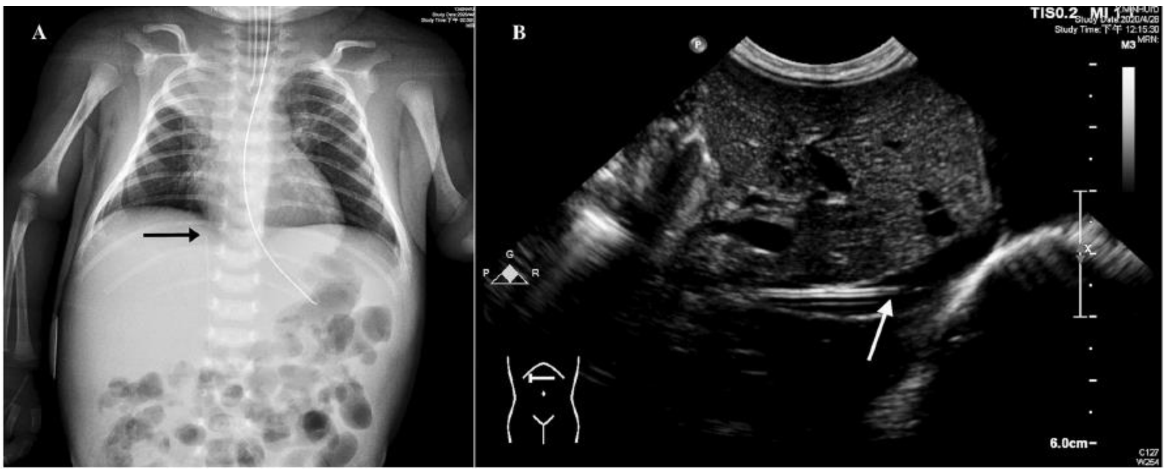

Fig. 2 The tip location of PCVC in (A) black arrow CXR & (B) white arrow Ultrasonography of the same patient.

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VI. DISCUSSION

In this study it has been observed that the time taken for locating the tip of the PCVCs is significantly shorter when confirmed by USG. The withdrawal rate is also comparatively very less in USG group when compared with CXR group. However there was no significant difference seen in demographic and complication data. As the USG examination helps in locating tip of PCVCs in 3-5mins, which is very quick, it allows the use of nutritional supplemenation and drugs immediately after procedure so that the quality of management of neonates can also be improved. Malposition of PCVCs can cause severe complications like vessel perforation, pericardial effusion, cardiac arrythmias, thrombosis, embolism, hepatic necrosis and tamponade which are fatal to the neonates.[15,16] This complications can be prevented by real time assessment through USG and along with it USG also has several benefits like no radiation exposure, less movement of neonates and reposition of PCVCs immediately.[17]Only a few studies have examined RTUS-guided PCVCs insertion in the NICU but the results are encouraging. USG examinations appear to be well tolerated even by preterminfants.[6,18,19] Significant reductions in total procedure time, number of line manipulations, and number of XRs have been observed, with no significant complications reported.[18,19]Similiar studies for locating tip of PCVCs were done and the duration taken by them was also close to our study like Simanovsky et al reported being able to visualize the catheter tip within an average 3 minutes, and Ohki et al were able to accomplish almost all their US assessments within a 10 minutes timeframe.[8,14] In our study we have opted to insert PCVCs in lower extremeties becauase the neonates need long term nutrition and drugs and mostly are very premature, for which they need nasogastric tube and endotracheal tube insertion in neck region and also the lung inflation due to ventilation hampers the USG vision. Also it is difficult to visualize the tip location in upper extremeties using USG high parasternal view due to earlier mentioned issues. Results of a previous randomized controlled study also revealed that US-guided PCVC placement could effectively reduce catheter insertion duration and that it was associated with fewer manipulations and radiographs when compared with conventional placement.[20]

VII. CONCLUSION

This study suggests that USG should be a replacement to routine CXR for confirmation of tip location of PCVCs as USG is convenient and accurate tool for confirming tip location and also RTUS guidance minimize the risk of complication due to line malposition. Along with it USG guided insertion of PCVCs has less withdrawal and no radiation exposure. However, it is unclear that how much training and experience is required for an individual to be said as competent for reliable and clinically beneficial bedside USG evaluations. Hence USG techniques are required in training programs of PCVC placement. Further more studies and training are required to make USG guided insertion and location of tip confirmation procedure as a standard procedure.

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