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Image Guided Techniques for Central Venous Access in Critically Ill Pediatric Patients

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Abstract

Background: Image guided inserted central venous catheters are used extensively in neonates and children.

Aim of Study: This study aimed to evaluate the technical and functional aspects concerning image guided central venous lines in critically ill pediatric patients.

Patients and Methods: This prospective study done included 20 pediatric patients, 10 patients of them underwent peripheral central catheters insertion while, the other 10 patients had traditional central venous lines using ultrasound and/or fluoroscopy guidance for different indications.

Results: Venous access devices (VADs) were successfully provided for 20 patients. There were 12 males (60%) and 8 females (40%) with a mean age of 4.91 years (range, 0-15 years). The right internal jugular vein was the main site of entrance for 5 cases (25%); 2 patients coming for bone marrow transplantation BMT & 3 patients on regular hemodialysis. The left internal jugular vein was used for 3 cases (15%); 2 cases on hemodialysis and one case for BMT. The right subclavian vein was used in 4 cases (20%) with end stage renal disease on hemodialysis. The left femoral vein was used for 3 (15%) PICC lines with septic shock and inotropes. The right femoral vein was used for 2 (10%) PICC lines with multisystem organ failure. The right basilic vein was used for 1 PICC line (5%) and the left greater saphenous vein was used in another 2 PICC lines (10%).

Conclusion: Image guided vascular venous access technique is considered as a feasible, safe and valuable option in critically ill pediatric patients.

Key Words: *Peripheral inserted central catheter (PICC) – Venous access devices – Image guided – Ultrasound guided.*

Introduction

CENTRAL venous catheter placement has became routine technique in pediatric intensive care practice. Such procedure especially in small infants, is more difficult than in adult patients due to factors such as vein size, lack of patient cooperation and higher frequency of anatomical variations. Critical illness adds more challenge with increased risk of complications **[1]**.

Central venous lines are essential in the managment of pediatric crtitically ill patients treated in surgical, intensive care and oncological / hematological units. Traditionally clinicians have used non-tunneled or tunneled, central venous catheters or subcutaneous venous ports reaching the superior vena cava via the internal jugular or subclavian veins according to the indication and the duration required for the central venous access. The placement of these lines carries a significant risk for serious complications, e.g. pneumothorax, arterial puncture, haemothorax, stroke, arrhythmias and nerve damage **[2]**.

The use of ultrasound has became an essential tool for central venous access especially in pediatric patients vascular being more difficult than in adults because of the smaller size of the vessels and the inability of the patient to cooperate **[3]**.

Current guidelines recommend ultrasound-guided vascular access for children in paediatric intensive care unit **[1]**.

International evidence-based recommendations on ultrasound-guided vascular access suggest using ultrasound not only to guide catheter placement but also to select the appropriate size of catheter, verify catheter tip placement, and rule out catheter-related complications **[4]**.

Recently, Doppler ultrasound has been used for PICC insertion that allowed proper visualization of the vessel, its anatomical variations, and the identification of any other factors that may affect

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the procedure's effectiveness; presence of valves, vein caliber, and quality of blood flow. Image guidance can reduce the number of punctures required for successful insertion of the catheter and can rthe procedure time [5].

Peripherally inserted central catheters (PICCs) are minimally invasive devices for central venous access for weeks or months for vesicant medications, administration of fluids and blood products, or blood sampling, and may facilitate early hospital discharge and home therapy. Despite them any benefits of PICCs, “minimally invasive” does not equal to “minimal risk” for the pediatric patient at the time of insertion or during the PICC dwell time [6].

PICC use has also extended beyond the hospital to ambulatory care, skilled nursing facilities, and homecare. The increase in PICC use is due to fewer insertion complications and less insertion duration than other central venous catheters (CVCs). The use of ultrasound guided PICC insertion has improved difficult venous access by visualization of vein size, patency, and venous flow [7].

Recently, Doppler ultrasound has been used for PICC positioning, allowing the visualization of the vessel, its anatomical variations, and the identification of characteristics that may influence the procedure's effectiveness, such as the presence of valves, vein caliber, and quality of blood flow. US guidance can reduce the number of attempts required for successful positioning of the catheter and can decrease the procedure time [5].

The National Institute for Clinical Excellence (NICE) in the United Kingdom NICE recommended that all catheters used for parenteral nutrition should be monitored and cared for by trained and experienced health care professionals using strict aseptic techniques, and complications including infection should be audited [8].

Aim of the work:

To evaluate the Technical and functional aspects concerning image guided central venous access in critically ill pediatric patients.

Patients and Methods

We preformed insertions of central venous catheters and peripherally inserted central catheters for twenty patient requiring vascular access in pediatric intensive care unit between September 2015 and June 2016.

All procedures were performed in the “Vascular and Interventional Unit” of Cairo University Children's Hospital (Abu El-Rish Hospital).

Inclusion criteria:

All patients under the age of 15 years requiring intermediate or long term I.V. access, or pediatric patient with failed peripheral cannulation in the intensive care unit.

Exclusion criteria:

- Any patient above the age of 15 years.
- Deep venous thrombosis, bleeding tendency, infective endocarditis.
- Patients not fit for general anesthesia.

Pre -procedure assessment & preparation:

Clinical and laboratory:

History (personal, detailed present, past and family history), Physical examination included an assessment of vital signs, pulmonary and cardiac status.

The protocol of management was discussed & planned with the referring physician. Then explanation of the decided protocol of treatment and its possible complications to the patient's parents was done. Informed consent was taken in all cases.

Blood work was performed and revised (CBC, kidney function tests, PT, PC and INR). Patients requiring anesthesia were examined by the anesthesiologist who reviewed their blood work, ECG and/or echocardiography to assess their eligibility.

Imaging:

All previous radiological investigations including Doppler ultra-sound, CT, MRI studies of the patients were reviewed. Intra-operative Doppler ultrasound examination of the patients was done, to understand the target vessel geometry and patency, as well as to exclude central occlusion & anatomical variations.

Technique:

Doppler ultrasound examination of the target vessel & planning for site of entrance, local anesthesia was given. A high-frequency linear array transducer (7.5-11MHz) was used. The transducer was covered with a sterile sleeve or sterilized with alcohol & betadine, then used for real-time vascular puncture. The transducer was oriented transversely in cases of jugular vein punctures, and longitudinal to the vessel being punctured in the rest of cases. After localizing the target vessel, the puncture needle was advanced into the subcutaneous tissues (Fig. 1). The needle tip was identified in the tissues by placing the US transducer almost directly over the skin puncture site. When the tip was confidently identified, the needle was slowly advanced toward the target vessel. The US transducer was slowly advanced keeping the needle tip and target vein in view. Single wall puncture was achieved by changing the angle of puncture such that the needle became more parallel to the vessel especially with superficial veins. Achieving a single-wall puncture ensured successful catheterization. After the front wall of the vein was punctured, the needle tip was identified within the lumen (Fig. 2). The needle was advanced within the vessel lumen using US to avoid puncturing the back wall.

A- PICC lines:

The following set was used: Medcomp single /double vascu-PICC basic set 3fr x 60cm (single lumen) and 4fr x 60cm (single and double lumen).

The appropriate vein was chosen for insertion. Then, cannulation of the target vein using the introducer needle under US guidance. The guide wire Inserted under fluoroscopic guidance. Withdrawal of the needle. Introduction of the peel-away sheath over the wire (Figs. 3,4). The length of catheter is adjusted according to the required tip position using the measurement tape; the remaining part is cut off. Remove the wire & dilator. Finally advancement of the PICC line with the stylet under fluoroscopic guidance & adjusting tip position at right atrium or atriocaval junction, then removal of the stylet (Figs. 5,6).

B- Non tunneled central lines:

The following sets were used:

Amecath 8fr x10cm & 9fr x12cm temporary dialysis catheters.

The right internal jugular vein was used in most cases. The ultrasound transducer was oriented transverse to the jugular vein, and the puncture was made longitudinal to the transducer, approaching the vein laterally. This allowed the catheter to have a gentler curve into the vein and prevents kinking. The guide wire was introduced. The puncture site was dilated using the set dilators (Fig. 7). The catheter was advanced over the guide wire under fluoroscopy (Fig. 8), and the guide wire was removed. The catheter was immediately accessed and flushed with saline & heparin lock (Fig. 9). Sutures (non-absorbable silk 2.0 or prolene 2.0) applied at exit site to secure catheter.

C- Tunneled central lines:

The following sets were used:

Tunneled PICC: Medcomp single lumen CVC Basic kit (7fr x 90cm).

Dialysis catheter (permecath): Medcomp Hemocath silicon double lumen catheter set 8fr x 18cm (cuff 15cm from tip).

Same steps as explained in short term central line were used till insertion of the guide wire. The subcutaneous tunnel was created. An exit site approximately midway between nipple and axilla was selected, avoiding breast tissue in female patients (Fig. 10). After a small incision was made, the tract entrance was expanded with blunt dissection. A plastic or metallic tunneler (blunt trocar) with the catheter attached to its end was used allowing the catheter to be pulled through the tunnel, exiting at the venipuncture site in the neck. The catheter with Dacron cuff was then pulled well into the tunnel so that the cuff was approximately at midpoint of the tunnel. The catheter length was either predetermined in case of using a haemodialysis catheter by selecting appropriate cuff-to-tip length, or adjusted by cutting the catheter to length using fluoroscopy while the catheter was laid over the patient's chest in case of Hickman's catheters.

After that, attention returned to the venipuncture site. The peel-away sheath was introduced, and preparation for catheter insertion was made. During the subsequent step, the dilator was removed from the peel-away sheath and the catheter was introduced. The risk of air embolism was minimized by having the patient suspend respiration or applying positive-pressure ventilation with anesthesia. The dilator & wire were quickly removed and the catheter tip introduced into the peel-away sheath. The tip position at atriocaval junction or within right atrium was verified with fluoroscopy and the sheath removed (Fig. 11). Fluoroscopy of the entire catheter course confirmed that there were no kinks or twists in the catheter. In two dialysis cases, the guide wire was inserted to help straighten and reposition the catheter. The catheter was immediately accessed and flushed with saline & heparin lock. Sutures (non-absorbable silk 2.0 or prolene 2.0) were applied at exit site to secure catheter.

Post -procedural care & follow-up:

- The patient was kept at bed rest in a flat position, especially those recovering from general anesthesia, for 1-2 hours.

- Post procedural Doppler assessment of the targeted vein patency was performed.
- Post-procedural medical management was prescribed according to the the patient condition, Analgesics for puncture site pain.
- If any complication occurred, the suitable imaging modality was done (either plain X-ray, fluoroscopy with contrast injection or CT), aiming for exact explanation of its cause.

Instructions to the physician & patient:

Special instruction were given to the caring physician and/or nurse regarding handling of the catheter to prolong its duration & minimize the complications including:

- Using aseptic technique while using the catheter & changing the dressing.
- Careful handling of the catheter to avoid dislodgement.
- Flushing the catheter with saline before & after usage as well as applying heparin lock.
- Checking for any emerging complications such as infection at puncture site or tunnel, catheter obstruction or extra-vasation, and reporting such complications to the interventionist.

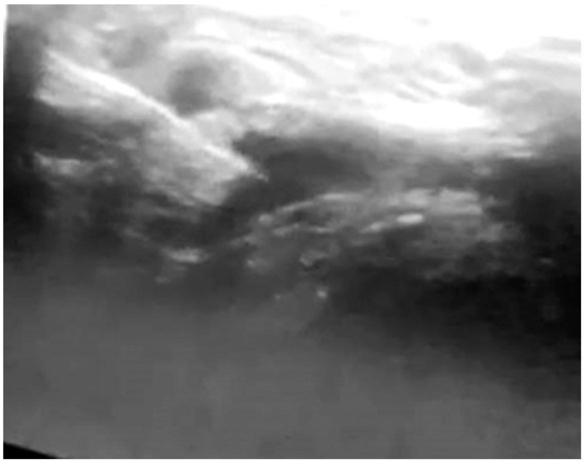

Fig. (1): Longitudinal ultrasound view showing puncture of anterior wall of the vein by the needle.

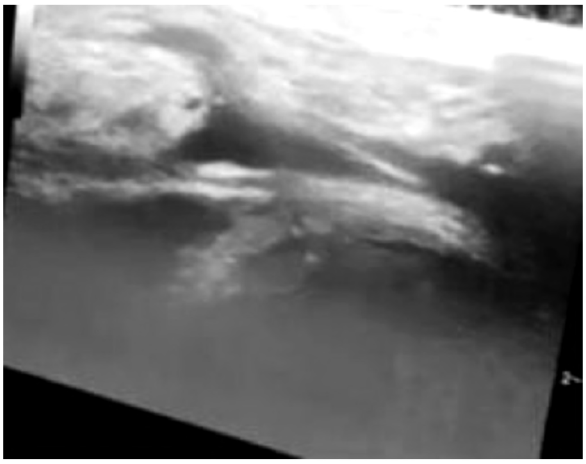

Fig. (2): After successful single wall puncture of the vein, introduction of the needle into vein lumen is done under ultrasound guidance.

Fig. (3): Introduction of the PICC line into the peel away sheath.

Fig. (4): Peeling of the sheath over the catheter.

Fig. (5): Confirmation of the tip of the left femoral PICC line at atriocaval junction.

Fig. (6): Fixation of the PICC line to the skin.

Fig. (7): Introduction of the dilator over guide wire.

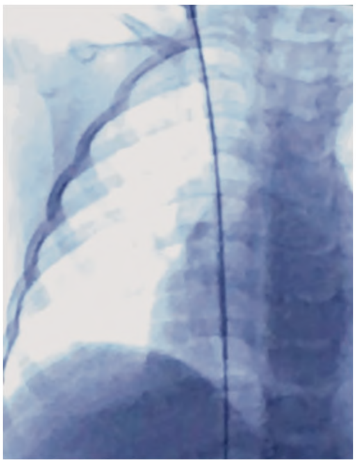

Fig. (8): Introducing the catheter over the guide wire under fluoroscopy.

Fig. (9): Flushing the catheter with saline and heparin.

Fig. (10): Exit site of the tunneled catheter.

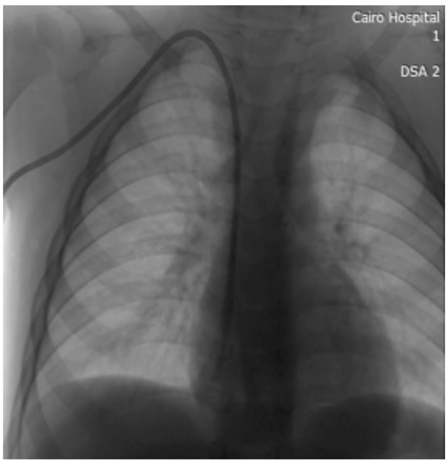

Fig. (11): Confirmation of the position and course of the tunneled catheter under fluoroscopy.

Results

Venous access devices were provided for 20 patients. There were 12 males (60%) and 8 females (40%) with a mean age of 4.91 years (range, 0-15 years), (Charts 1,2).

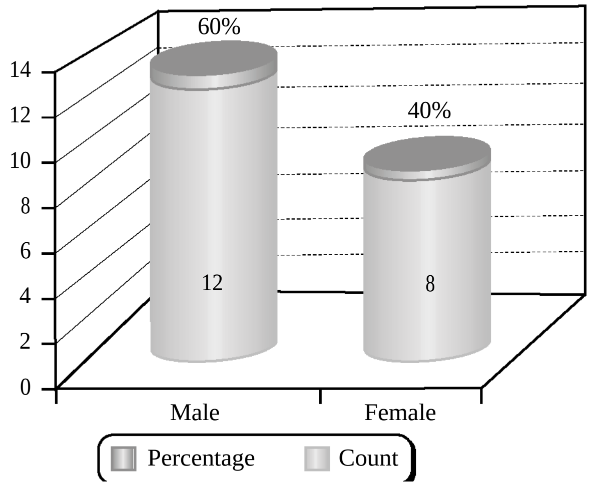

Chart (1): Sex of patients.

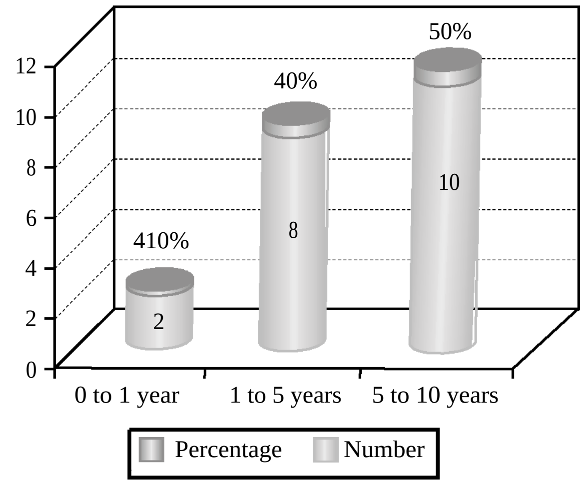

Chart (2): Age of patients.

Out of the 20 patients, 9 of them had chronic renal failure and were on hemodialysis, 3 were prepared for bone marrow transplantation and needed IV infusion therapy during their hospital stay, 7 patients had septic shock and multisystem organ failure needed PICC lines for IV fluid infusion and inotropes (Table 1 & Chart 3).

Table (1): Clinical presentation.

	Number of patients	%
Dialysis	9	45
Preparation for BMT	3	15
Septic shock and multisystem organ failure	7	35
Other causes	1	5
Total	20	100

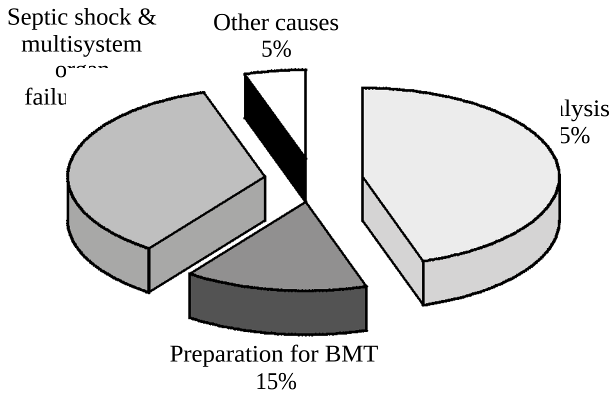

Chart (3): Clinical presentation.

Choice of venous access device:

- Medcomp single vascu-PICC basic set 3fr x 60cm and double lumen PICC 4fr x 60cm were used in 8 patients for inotropes, multisystem organ failure and aplastic anemia.
- Non tunneled Amecath central lines 8fr x 10cm & 9fr x 12cm were used in 4 patients with chronic renal failure.
- Tunneled central lines: Medcomp double lumen PICC Basic kit (5fr x 60cm) and Dialysis catheter (permacath): Medcomp Hemo-cath silicon double lumen catheter set 8fr x 18cm (cuff 15cm from tip) were used in 5 patients with chronic renal failure and 3 patients prepared to BMT.

Table (2): Types of VAD.

Duration	Type	Size	Count
Intermediate term	PICC	4fr x 60cm	5
	Non tunneled	3fr x 60cm	3
	Amecath	8fr x 10cm	4
	CVC	9frx 12 cm	3
Long term	Tunneled PICC	5fr x 60 cm	5
	Tunneled dialysis	8fr x 18cm	
	CVC		
Total			20

Puncture sites:

- The right internal jugular vein was the main site of entrance for 5 cases; 2 patients coming for BMT & 3 patients on hemodialysis.
- The left internal jugular vein was used for 3 cases; 1 patient for BMT, and 2 cases on hemodialysis.
- The right subclavian vein was used in 4 cases on hemodialysis.
- The left femoral vein was used for 3 PICC lines with septic shock and inotropes.

- The right femoral vein was used for 2 PICC lines with multisystem organ failure.
- The right basilic vein was used for 1 PICC line for inotropes.
- The left greater saphenous vein was used in 2 PICC line case coming with sepsis.

Procedural details:

1- Use of ultrasound:

Ultrasound guidance was used for all cases.

2- Use of fluoroscopy / X ray:

Intermittent fluoroscopic guidance was used for most of cases.

3- Contrast injection:

Intra-procedural contrast injection was performed in 12 cases (tunneled lines and non tunneled dialysis catheter); the aim of contrast injection was to confirm patency of central veins, detect collaterals or to check flow around catheter tip & side halls.

4- Types of anesthesia:

General anesthesia was used in 12 patients whom procedure were performed in the "Vascular and Interventional Unit", While 8 ICU patients at bed side underwent sedation done by pediatrician, (Table 3).

Table (3): Types of anesthesia.

Type of anesthesia	Number of patients	%
General	12	60
Bed side sedation	8	40
Total	20	100

5- Intra -procedural complications:

In all patients, only 1 PICC line patient was complicated by a small hematoma that was controlled by manual compression, and the procedure was completed successfully, follow-up Doppler ultrasound revealed no arterial stenosis or dissection, the hematoma resolved within 1 week.

Immediate outcomes:

Technical success was defined as achieving the venous puncture, insertion of the VAD with tip position at atriocaval junction or within the right atrium with free in & out flow through the catheter (Table 4).

Table (4): Immediate outcomes.

Immediate outcome	Count	%
Catheter tip at Atriocaval junction	15	75
Catheter tip at right atrium	4	20
Catheter tip at IVC	1	5
Intra-operative complications	1	5
Contrast injection confirmed free flow & no extra-vasation	20	100
Free in & out flow with no resistance	20	100

For the dialysis catheters, adequate in & out flow was observed through the side openings & tip of the inserted catheters in all dialysis patients.

Fluoroscopy was used to confirm absence of kinks along the course of the inserted catheters, tip positioning & free flow of contrast through the catheter with opacification of the right atrium & absence of extra-vasation.

No kinks or contrast extra-vasation were encountered.

One month follow-up:

During the 1st month follow-up period all patients didn't suffer any late complications with adequately functioning access devices.

The bone marrow transplant patient developed febrile neutropenia with positive blood culture from the catheter & the catheter had to be exchanged with a new one in a 2nd session.

Discussion

Establishing and maintaining venous access forms an increasing proportion of the workload in interventional radiology due to the role image guided techniques in safe placement of these devices especially in pediatric patients admitted in the intensive care units who need intermediate to long term venous access.

We used ultrasound and/or fluoroscopy guidance in all cases with the use of contrast venography in some patients aiming at reducing the complications rate & shortening the procedural time.

Twenty patients were included in our study & were divided into 2 groups according to the type of catheter used (central venous lines and PICC lines); they underwent full history taking, clinical examination and laboratory tests. They were referred form pediatric department. They had different indications for venous access. The choices of the catheter type as well as the access route were planned carefully according to the indication & available sites of insertion.

Patients were followed-up clinically & radiologically for one month and all complications were reported.

In our study, the mean age of the patients was 4.91 years. The patients' ages ranged between 0 & 15 years which explains the broad need for venous access among different age groups of children & elaborates the important role played by interventional radiologists to provide such access.

In our study, there was a male predominance. We performed the venous access for 12 males and only 8 females, that is to say that males represented 60% and females 40%, however the male predominance was mostly in the dialysis group.

In our study, 2 main categories contributed to more than 65% of the cases, these categories were patients who needed haemodialysis & patients who needed venous access for IV therapy and fluids.

Best practice guidelines that clearly define indications for PICC insertion and removal in children are lacking [9]. Peripheral vascular access is a real challenge in pediatrics, and a PICC is seen as a useful alternative because it provides secure central access, avoids the psychological trauma of repeated intra venous access, and enables early hospital discharge for a child [6].

Our strategy for choosing a vascular access device was primarily dependent on the purpose for the line i.e. the indication for venous access.

In our study the intermediate PICC lines are ideal in patients admitted in PICU with necessary continuous IV therapy and fluids. While the long term central lines are ideal for continuous, long term infusions, as in patients undergoing bone marrow transplantation, as well as patients on regular haemodialysis.

This study used long term tunneled, cuffed access lines for prolonged use. In our study tunneled and non-tunneled catheters were used for haemodialysis as well as for patients awaiting bone marrow transplant.

And that agreed with other studies confirming PICCs are ideal for short-term access, whereas surgically tunneled cuffed central venous lines such as Hickman/Broviac catheters are more tolerable for long-term venous access [11].

Cuffed PICC lines could be used for long term access as we conducted in our study for patients undergoing bone marrow transplantation which agree with other study who highlighted the potential role of PICC lines for prolonged use in children with malignancies, not for short use only [12].

Double- and triple-lumen PICCs are often needed to meet the needs of critically ill patients and decrease the need for multiple vascular access devices which was of great benefit to patients in PICU with septic shock who needed continuous simultaneous IV inotropes infusion as well as IV fluids and other IV drugs infusions [13].

The internal jugular & subclavian veins are favored access sites for tunneled and non-tunneled devices. Subclavian venous catheters are better avoided in patients with severe hypoxemia as pneumothorax is less readily tolerated. Subclavian access is relatively contra-indicated in dialysis patients to avoid subclavian stenosis and catheter kink. A low right internal jugular access has the least likelihood to develop catheter dysfunction, venous stenosis or occlusion and to deliver higher flow rates for dialysis patients [14]. We followed these results in our study, where the right IJV was the 1st choice for puncture site for the central lines followed by the left IJV.

For the PICC lines, 5 (25%) patients had their lines inserted through the femoral vein at upper thigh yet Uygun I. his colleagues recommended the long saphenous vein as first preference because it offers easy cannulation, dressing, and stabilization [15].

All patients were subjected to general anesthesia or bedside sedation. This is of particular importance as most patients needing venous access have comorbidities that affect their tolerance to general anesthesia.

This study used ultrasound guidance with all patients in order to reduce the complications rate & shorten the procedure time. We aimed at pointing out the paramount role of ultrasound guidance in the provision of venous access devices & inherently the important role played by interventional radiologist being the pioneers in ultrasound use.

Studies report that ultrasound guided puncture provides access to vessels more safely and provides more chances of success on the first attempt to puncture [16], the major advantage of sonography is the lack of ionizing radiation. Other advantages of sonography are the ability to primarily evaluate the catheter tip with respect to branching vessels and cardiac chambers, identification of catheter tip thrombosis [17].

Combined intermittent fluoroscopy was used in 12 cases. The role of fluoroscopy and venography was: (a) To confirm central venous occlusion or stenosis & to assess collateral circulation as an alternate route, (b) To monitor the guide wire progress to avoid any misplacement, (c) To ensure proper catheter placement & proper tip positioning & finally, (d) To ensure absence of complications such as catheter rupture, obstruction or extravasation. The one point of particular importance on using fluoroscopy is the adjustment of catheter length to ensure a proper tip position since this affects the long term outcome of the catheter inserted.

The catheter tip position has emerged as the main independent prognostic factor for malfunction and reduced duration of the device, placement of the catheter tip high in the SVC results in a higher incidence of thrombosis than low placement in the SVC or at the atriocaval junction **[18]**.

Following these guidelines in our study, **[15]** of the catheters tips were positioned at the right atriocaval junction (75% of the cases).

No catheter rupture, obstruction or extravasation was encountered during the sessions for all patients.

In all patients, we succeeded in achieving the venous puncture, establishing the subcutaneous tunnel (whenever applicable) & inserting the PICC and CVC lines with free in & out flow through the catheter.

In only 1 case (5% of the patients), developed small hematoma related to puncture that were self-limited & resolved few days after the procedure.

No major complications such as pneumothorax, vascular thrombosis & large growing hematomas were encountered in our study. This agrees with results obtained by Reusz G and his colleagues **[19]**, who succeeded in CVC insertion in 41 patients with severe uncorrected coagulopathy and in a further 76 patients with coagulopathy of moderate severity using ultrasound guidance with no associated major complications.

No major complication such as, pneumothorax, thrombosis or sepsis was encountered in our study with a technical success was 100%.

It has been stated that peripherally inserted central venous catheters have a lower infection icnidence compared to other central venous lines **[21]**.

Catheter dislodgment raises the importance of educating the nurses and the patients about the catheter care & ideal dealing with the catheter. Low degree infection can sometimes erode the fibrous tissue in the subcutaneous tunnel making it loose **[18]**.

If the low incidence of PICCs complications including infections can be validated in children, then PICCs should become alternatives to conventional CVCs for children, because PICCs avoid surgical intervention and reduce the risk of life-threatening complications **[11]**.

Conclusion:

PICCs are emerging as a feasible, safe and valuable option for intermediate- to long-term IV fluid and medical therapy (central venous access) in children alternative to other central catheters, and they can be used in hospitals (in radiology department or as bedside procedure) and outpatient settings. PICC insertion is easy to learn, has very few serious risks, and can often be performed in general or local anesthesia.

Ultrasound and/or fluoroscopy are showed excellent effectiveness in evaluation of both peripherally inserted central venous catheters and traditional CVCs lines. They can decrease the incidence of complications and reduced the time spent on the procedure.

References

1- OULEGO-ERROZ I., GONZÁLEZ-CORTES R., GARCÍA-SOLER P., BALAGUER-GARGALLO M., FRÍAS-PÉREZ M., MAYORDOMO-COLUNGA J., et al.: Ultrasound-guided or landmark techniques for central venous catheter placement in critically ill children Antonio Rodríguez-Núñez 16 and RECANVA collaborative study. Intensive Care Med., 44: 61-72, 2018.

2- JOHANSSON E., HAMMARSKJÖLD F., LUNDBERG D. and ARNLIND M.H.: Advantages and disadvantages of peripherally inserted central venous catheters (PICC) compared to other central venous lines: A systematic review of the literature. Acta. Oncol. [Internet]. Jun [cited 2022 Oct 8]; 52 (5): 886-92. Available from: https://pubmed.ncbi.nlm.nih.gov/23472835/, 2013.

3- SCHINDLER E., SCHEARS G.J., HALL S.R., YAMAMOTO T., EHRENFRIED SCHINDLER C. and KLINIK SANKT AUGUSTIN A.: Ultrasound for vascular access in pediatric patients. Pediatric Anesthesia [Internet]. Oct 1 [cited 2022 Oct 13]; 22 (10): 1002-7. Available from: https://onlinelibrary.wiley.com/doi/full/10.1111/pan. 12005, 2012.

4- NAIK V.M., SHYAM PRASAD MANTHA S. and RAYANI B.K.: Vascular access in children. Indian J. Anaesth. [Internet]. Sep 1 [cited 2022 Oct 14]; 63 (9): 737. Available from: /pmc/articles/PMC6761776/, 2019.

5- DE CARVALHO ONOFRE P.S., DA LUZ GONÇALVES PEDREIRA M. and PETERLINI M.A.S.: Placement of peripherally inserted central catheters in children guided by ultrasound: A prospective randomized, and controlled trial. Pediatr Crit Care Med. [Internet]. Sep [cited 2022 Oct 8]; 13 (5). Available from: https://pubmed.ncbi.nlm.nih.gov/22622651/, 2012.

6- GIBSON C., CONNOLLY B.L., MOINEDDIN R., MAHANT S., FILIPESCU D. and AMARAL J.G.: Peripherally inserted central catheters: Use at a tertiary care pediatric center. J Vasc Interv Radiol [Internet]. Sep [cited 2022 Oct 8];24(9):1323-31. Available from: https://pubmed.ncbi.nlm.nih.gov/23876551/, 2013.

7- EVANS R.S., SHARP J.H., LINFORD L.H., LLOYD J.F., WOLLER S.C., STEVENS S.M., et al.: Reduction of peripherally inserted central catheter-associated DVT. Chest [Internet]. [cited 2022 Oct 8]; 143 (3): 627-33. Available from: https://pubmed.ncbi.nlm.nih.gov/22878346/, 2013.

8- NJERE I., ISLAM S., PARISH D., KUNA J. and KESHTGAR A.S.: Outcome of peripherally inserted central venous catheters in surgical and medical neonates. J. Pediatr Surg [Internet]. May [cited 2022 Oct 8]; 46 (5): 946-50. Available from: https://www.academia.edu/12601170/Outcome_of_peripherally_inserted_central_venous_catheters_in_surgical_and_medical_neonates, 2011.

9- CHOPRA V., FLANDERS S.A. and SAINT S.: The problem with peripherally inserted central catheters. JAMA [Internet]. Oct 17 [cited 2022 Oct 8]; 308 (15): 1527-8. Available from: https://pubmed.ncbi.nlm.nih.gov/23073947/, 2012.

10- VAN DEN HOOGEN A., BROUWER M.J., GERARDS L.J., FLEER A. and KREDIET T.G.: Removal of percutaneously inserted central venous catheters in neonates is associated with the occurrence of sepsis. Acta. Paediatr. [Internet]. Sep [cited 2022 Oct 8]; 97 (9): 1250-2. Available from: https://pubmed.ncbi.nlm.nih.gov/18477060/, 2008.

11- HATAKEYAMA N., HORI T., YAMAMOTO M., MIZUE N., INAZAWA N., IGARASHI K., et al.: An evaluation of peripherally inserted central venous catheters for children with cancer requiring long-term venous access. Int J Hematol [Internet]. [cited 2022 Oct 8]; 94 (4): 372-7. Available from: https://pubmed.ncbi.nlm.nih.gov/21904952/, 2011.

12- ABEDIN S. and KAPOOR G.: Peripherally inserted central venous catheters are a good option for prolonged venous access in children with cancer. Pediatr Blood Cancer [Internet]. Aug [cited 2022 Oct 8]; 51 (2): 251-5. Available from: https://pubmed.ncbi.nlm.nih.gov/18421718/, 2008.

13- NICHOLSON J.: Development of an ultrasound-guided PICC insertion service. Br. J. Nurs. [Internet]. May 27 [cited 2022 Oct 8]; 19 (10). Available from: https://pubmed.ncbi.nlm.nih.gov/20622768/, 2010.

14- BOSE N., PATEL H. and KAMAT H.: Evaluation of ultrasound for central venous access in ICU by an in experienced trainee. Indian J. Crit Care Med. [Internet]. Jan 1 [cited 2022 Oct 8];18(1):26. Available from: /pmc/articles/PMC3912664/, 2014.

15- UYGUN I.: Peripherally inserted central catheter in neonates: A safe and easy insertion technique. J. Pediatr. Surg. [Internet]. Jan 1 [cited 2022 Oct 8]; 51 (1): 188-91. Available from: https://pubmed.ncbi.nlm.nih.gov/26364881/, 2016.

16- LARUE G.D.: Efficacy of ultrasonography in peripheral venous cannulation. J. Intraven Nurs. [Internet]. Jan 1 [cited 2022 Oct 8]; 23 (1): 29-34. Available from: https://europepmc.org/article/med/11013531, 2000.

17- SAUL D., AJAYI S., SCHUTZMAN D.L. and HORROW M.M.: Sonography for Complete Evaluation of Neonatal Intensive Care Unit Central Support Devices: A Pilot Study. J. Ultrasound Med. [Internet]. Jul 1 [cited 2022 Oct 8]; 35 (7): 1465-73. Available from: https://pubmed.ncbi.nlm.nih.gov/27229130/, 2016.

18- GRANZIERA E., SCARPA M., CICCARESE A., FILIP B., CAGOL M., MANFREDI V., et al. Totally implantable venous access devices: Retrospective analysis of different insertion techniques and predictors of complications in 796 devices implanted in a single institution. BMC Surg [Internet]. May 8 [cited 2022 Oct 8]; 14 (1): 1-9. Available from: https://bmcsurg.biomedcentral.com/articles/10.1186/1471-2482-14-27, 2014.

19- REUSZ G., LANGER C., EGERVARI G., SARKANY P. and CSOMOS A.: Safety of ultrasound-guided central venous access in critically ill patients with uncorrected coagulopathy. Crit Care [Internet]. Apr. [cited 2022 Oct 8]; 17 (Suppl 2): P173. Available from: /pmc/articles/PMC3642401/, 2013.

20- SEOK J.P., KIM Y.J., CHO H.M., RYU H.Y., HWANG W.J. and SUNG T.Y.: A Retrospective Clinical Study: Complications of Totally Implanted Central Venous Access Ports. Korean J Thorac Cardiovasc Surg [Internet]. Feb [cited 2022 Oct 8]; 47 (1): 26. Available from: /pmc/articles/PMC3928259/, 2014.

21- MAKI D.G., KLUGER D.M. and CRNICH C.J.: The risk of bloodstream infection in adults with different intravascular devices: A systematic review of 200 published prospective studies. Mayo. Clin. Proc. [Internet]. [cited 2022 Oct 8]; 81 (9): 1159-71. Available from: https://pubmed.ncbi.nlm.nih.gov/16970212/, 2006.

تقنيات تركيب القساطر الوريدية المركزية
فى الحالات الحرجة للأطفال تحت ارشاد الأشعة

أصبح استخدام القسطرة الوريدية المركزية تقنية روتينية فى ممارسة العناية المركزة للأطفال. مثل هذا الإجراء خاصة عند الرضع الصغار، يكون أكثر صعوبة من المرضى البالغين بسبب عدة عوامل مثل حجم الوريد، وعدم تعاون المريض وزيادة احتمالات الاختلافات التشريحية، تضيف الأمراض الحرجة مزيداً من التحدى مع زيادة خطر حدوث مضاعفات، على سبيل المثال استرواح الصدر، ونزيف بتجويف الصدر، والسكتة الدماغية، وعدم انتظام ضربات القلب.

أصبح استخدام الموجات فوق الصوتية أداة أساسية للوصول إلى الوريد المركزى خاصة فى مرضى الأطفال، وكان الهدف من هذه الدراسة تقييم الجوانب الفنية والوظيفية المتعلقة بتركيب القساطر الوريدية المركزية تحت ارشاد الأشعة والموجات فوق الصوتية فى مرضى الأطفال بوحدة الحالات الحرجة.

تظهر القسطرة المركزية المُدخلة طرفياً كخيار مجدى وآمن للعلاج لفترة متوسطة إلى طويلة المدى عند الأطفال كبديل للقسطرة المركزية الأخرى، ويمكن استخدامها فى المستشفيات، ولها مخاطر جدية قليلة جداً، ويمكن إجراؤها غالباً بالتخدير العام أو الموضعى.