Original Article

Safety and Utility of Various Intravenous Access Devices in a Newly Established Pediatric Hematology Oncology Unit in Central India: Is Midline an Acceptable Option?

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Abstract

Introduction: Recent advances in chemotherapy and supportive care have led to improved survival rates in paediatric oncology. Management of these patients requires safe and reliable intravenous access for various purposes, which can be achieved with midline, central venous catheters (CVC), peripherally inserted central catheters(PICC) and chemo-port. Each type of access has a its advantages and disadvantages. We have analysed the safety and utility of various intravenous access devices in pediatric oncology patients.

Methods: A single-centre prospective observational study was conducted in the Division of Paediatric Haematology Oncology, Department of Paediatrics, in a tertiary care hospital in central India. A total of 32 patients were enrolled (14 Midlines, 12 CVCs, 4 PICCs, 2 Chemo-ports). These were observed for catheter dwell time and complications.

Results: The median dwell time for all types of catheters was 30 days. The longest median catheter dwell time was for chemo-port (101 days), followed by midlines (30.4 days). The most frequent complication encountered in our study was thrombophlebitis (28%), followed by central line-associated bloodstream infections (CLABSI- 22%). Among CVCs, the most frequent complication was CLABSI(11.9 per 1000 catheter days). Among Midline catheters, the most frequent complication was thrombophlebitis(18.8 per 1000 catheter days). Among PICCs, one each of catheter leak, catheter fracture, thrombophlebitis and CLABSI was seen (21.7 per 1000 catheter days). Both chemo-ports were removed due to complications (one due to CLABSI and the other due to catheter migration into the right atrium).

Conclusions: Midlines can be used at newly established paediatric oncology centres as serious complications (CLABSI and deep catheter migration) are less common with midlines.

Keywords

Paediatric oncology, central venous access devices, dwell time, complications

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Introduction:

The outcome of childhood cancers has phenomenally improved in recent years due to earlier diagnosis, better use of multimodality treatment as per risk stratification, and better supportive care. The use of central venous access devices (CVADs) is an important part of supportive care in pediatric oncology. CVADs allow prolonged or continuous infusions of chemotherapy as per protocol requirements with reduced risk of extravasation and interruptions in therapy. The tip of a CVAD lies in the right atrium or a large vein like the superior vena cava. It can be of 3 types- peripherally inserted central catheter (PICC), central venous catheter or chemo-port. We also

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used a midline catheter, which is peripherally inserted but shorter than PICC, and the tip lies in a bigger peripheral vein but not in a central vein.

Peripheral venous access is the mainstay of vascular access both during hospital admission and outpatient basis.[1] Peripheral access is adequate for intravenous (IV) hydration, administration of common medications, and blood transfusion. It is usually more technically straightforward and safer than central access and can be performed at the bedside without anaesthesia.

Central venous access, though primarily used when prolonged intravenous access is warranted, is also used for the administration of life-saving medications, hyperosmolar fluids, total parenteral nutrition (TPN) and chemotherapeutic agents. This form of access needs more technical expertise for insertion and maintenance, with increased costs involved.[1] They also have an increased risk of serious complications like central line-associated bloodstream infections (CLABSI), deep vein thrombosis (DVT), bleeding, pneumothorax and sometimes difficult removal needing surgical intervention. So, central lines are avoided or less commonly used, even at many tertiary care centres in India. Even chemotherapy is given through peripheral lines due to the high risk of infections among these immunocompromised patients. Sometimes, parents also become reluctant to choose a central line after predicting/experiencing complications.

Midline catheters are intermediate in length (8-20 cm) and peripherally inserted, but the tip lies in a bigger peripheral vein (up to the axillary vein in the upper limb). Hence, they share the advantages and disadvantages of peripheral and central lines.[2,3] In centres where there is no trained team to take care of central lines, midlines can be used to start with. There is a paucity of literature regarding the use of midline catheters for chemotherapy/ irritant drugs, though even peripheral lines are commonly used for these purposes, especially in India. Some literature suggests that vesicant drug administration should not be done through midlines.[4] There is potential for the use of midlines at diagnosis of paediatric cancer due to the high chances of infection and thrombosis during induction chemotherapy needing catheter removal, resulting in increased morbidity and financial loss.

Various studies have evaluated the use of midline catheters in children requiring intravenous access for intermediate duration.[5-9] These studies were done in paediatric emergency and paediatric intensive care but not in paediatric oncology.

Materials and Methods

This is a single-centre, prospective observational study conducted in the Division of Paediatric Hematology, Oncology, Department of Paediatrics, in a tertiary care hospital in central India. The study period was from May 2019 to October 2022. Institutional ethics committee approval was taken, and prior consent and assent (wherever required) were obtained before enrolling patients. A total of 32 paediatric cancer patients were inserted with midline/CVAD based on clinical indication/choice. Demographic data, clinical details, and catheter type were recorded in a pre-approved proforma.

Various catheter types were observed for dwell time, number and type of complications and reasons for removal. Microsoft Excel was used for data entry, and EPI-Info 7 for data analysis. Descriptive statistics measures, i.e. mean and median, were used to summarise numerical data and percentages for summarising nominal data. Analysis of variance (ANOVA) was applied for comparison of population means. Further, p value<0.05 was considered significant.

Results

A total of 32 catheters were inserted in 29 patients. Demographic characteristics are depicted in Table 1. The median age of the study population was 9 years (IQR=6-12), with males 41% and females 59%. Acute lymphoblastic leukemia was the most common diagnosis (66%). Midlines were the most common catheters used(44%), followed by CVC (38%), PICC (12%) and chemo-port (6%).

Table 1. Demographic characteristics of the study population:

S No	Parameter	Value
1	Age	
	Median (IQR)	9 years (6-12)
2	Gender (n=29)	
	Male	41%
	Female	59%
3	Diagnosis (n=29)	
	B ALL	15(52%)
	T ALL	4 (14%)
	Ewings Sarcoma	4 (14%)
	Neuroblastoma	2 (6%)
	Burkitts Lymphoma	1 (3.5%)
	AML	1(3.5%)
	Hodgkins Lymphoma	1(3.5%)
	Rhabdomyosarcoma	1(3.5%)
4	Type of catheter (n=32)	
	Midline	14 (44%)
	CVC	12 (37.5%)
	PICC	4 (12.5%)

Chemo-port	2 (6%)

B ALL – B Acute Lymphoblastic Leukemia, T ALL – T Acute Lymphoblastic Leukemia, AML Acute Myeloid Leukemia, CVC – Central Venous Catheter, PICC – Peripherally Inserted Central Catheter

The median dwell time for all types of catheters was 30 days (Figure 1). The longest median catheter dwell time was for chemo-port (101 days), followed by midline

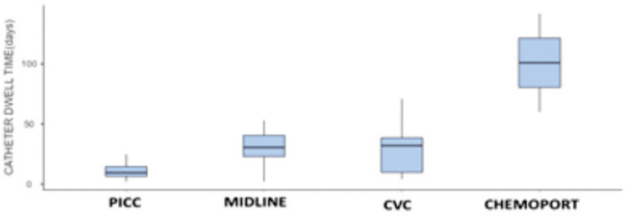
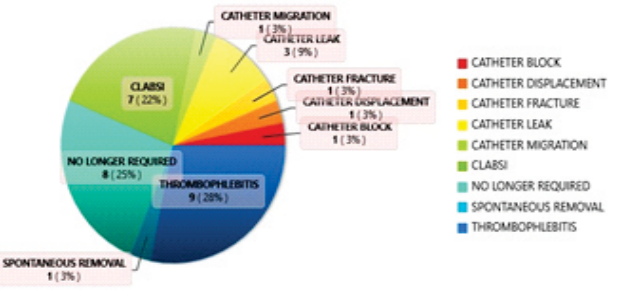


Figure 1: Median catheter dwell time among various catheterss

Overall, 24 catheters (75%) had one or other complication. The frequency of various complications is depicted in Figure 2. The most frequent complication was thrombophlebitis in 28%, followed by CLABSI in 22% and catheter leak in 9%. Catheter block,



displacement, fracture, migration, and accidental removal were among others.

Figure 2: Proportion of various complications across all CVADs

Complication rates per 1000 catheter days are depicted in Table 2. Thrombophlebitis rate was higher among peripherally inserted catheters like PICC (21.7 per 1000 catheter days) and midline (18.8 per 1000 catheter days). CLABSI rate was higher with PICC (21.7 per 1000 catheter days) and CVCs (11.9 per 1000 catheter days), compared to chemo-port (4.9 per 1000 catheter days) and midline (2.3 per 1000 catheter days). Overall complication rate was more common with the use of midlines [Odds ratio(OR): – 6, Confidence interval (CI)=0.9-39.1]. CLABSI was most

Table 2. Incidence of various complications per 1000 catheter days:

Catheter type	Complication	Incidence (per 1000 catheter days)
Midline	Thrombophlebitis	18.8
	Catheter Leak	4.7
	Catheter Block	2.3
	CLABSI	2.3
CVC	CLABSI	11.9
	Catheter displacement	2.9
	Spontaneous removal	2.9
PICC	Catheter Leak	21.7
	Catheter Fracture	21.7
	Thrombophlebitis	21.7
	CLABSI	21.7
Chemo-port	CLABSI	4.9
	Catheter Migration	4.9

CVC – Central Venous Catheter, PICC – Peripherally Inserted Central Catheter, CLABSI – Central Line Associated Blood Stream Infection

Discussion

The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC) recommends midlines in patients with difficult vascular access, for treatment that will likely exceed 6 days, and for patients requiring infusions including antibiotics for up to 14 days.[10,11] However, midline as a catheter of choice for venous access of intermediate duration has not been extensively evaluated. Also, evidence comparing complications of midlines with other CVADs is lacking in children.[5,12] In this study, we tried to assess whether midline can be used as a catheter of choice for administering chemotherapy for an intermediate duration.

The average catheter dwell time of CVCs in our study was 27.8 days, which was better than the dwell time of 10.54 days reported by Toulnay et al[13] in critically ill pediatric patients. This might be due to our policy to use

the catheter as long as needed if no complications are seen. In our study, catheter removal without complications was done only after prolonged venous access was no longer required. This might also explain the higher complication rate in our study (50%) as compared to similar studies[14] in critically ill children.One study with pediatric oncology patients reported a complication rate of 25%.[15]

In our study, among the six CVCs with complications, four had CLABSI, one was displaced, and one was accidentally removed. Arterial puncture, hematoma formation and pneumothorax are the common complications seen with CVCs but were not seen in our study.In a systematic review by Ullmann et al., the incidence of CLABSI in CVC was 5.85 per 1000 catheter days. In our study,the incidence of CLABSI was 11.9/1000 catheter days.[16] Prolonged catheter dwell time increases the risk of CLABSI. Various factors that might be correlated with increased CLABSI in our study were analysed, but no correlation was found between the duration of the catheter, type of cancer, age and gender of the patient with CLABSI.Molina et al. conducted a comparative study on the fixation of CVCs with sutures versus adhesive and concluded that the use of adhesive was associated with a lesser incidence of displacement.[17] In our study, both catheters with displacement/accidental removal were secured with 3-0 silk. Improper securing of the catheter to the skin might be the cause for displacement/accidental removal in our study.

The average catheter dwell time in Midline catheters was 30.4 days in our study, which is higher than the reported dwell time in literature, 7.69 to 16.4 days.[18-20] The overall complication reported in a multi-centre study by Chopra et al.was 10.3% at a rate of 2.1 complications per 1000 catheter days. In our study, 12 out of 14 catheters (87%) developed some complications, with an overall complication rate of 28.2 per 1000 catheter days.[19] The high complication rate in our study could be due to our policy to use midline catheters as long as possible till the development of complications or planned removal. However, no significant correlation was found between the duration of the catheter and the incidence of complications and complication rate was similar among catheters kept for shorter durations or longer duration. The most frequent complication in our study was thrombophlebitis (57%). In a systematic review by Adams et al., the incidence of thrombophlebitis was 11%. This difference could be due to the type of medication administered via midlines.In the previous study, midlines were used in PICU and emergency settings. In our study, all the lines were used in pediatric oncology where vesicant medications were given, and this is associated with an increased risk of thrombophlebitis.

The frequency of catheter leakage in midline catheters was higher (14%) in our study, as compared to the 2.24% reported by Chopra et al.[10] Leicket al. proposed that leakage occurs in a thrombosed vein when the flow is obstructed by thrombus[9], but in our study, we did not find any clinical or radiological evidence of thrombus on USG of the affected vein. In a study by Moureauet al. incidence of CLABSI in midline catheters was 0.2 per 1000 catheter days.[21] The incidence in our study was 2.3 per 1000 catheter days.We did not report thrombosis in our study, but Katerina et al. reported thrombosis in 4.5% of catheters.[22] The position of the tip of the catheter is a significant risk factor for developing thrombus, with increased risk if the tip is in the subclavian vein as compared to femoral or cubital veins.[23] In our study, the tip was located at the axillary vein, and this could be the reason for no thrombosis in our study.

The average catheter dwell time in PICCs was 11.5 days; this was comparable to the reported time in the literature (7.3 to 16.6 days).[24]: An Overall complication rate of 5.29 per 1000 catheters was reported by Fadoo et al.[25] In our study, the complication rate was 89.9 per 1000 catheter days. The incidence of CLABSI in our study was 21.7 per 1000 catheter days as compared to 2.3 per 1000 catheter days reported in the literature.[6] CLABSI seen in our study can be related to catheter manipulation after insertion because the length of the catheter was not properly measured before insertion.

The incidence of thrombophlebitis among PICC in our study was 21.7%, and this is slightly higher than that reported in the literature (10%).[26] This again depends on the type of medications administered through the line, and in our study, PICC with thrombophlebitis could be because of chemotherapy administration.One catheter was fractured due to the injection of radio-contrast through the PICC line by untrained staff. There was no displacement of the catheter fragment. There are cases reported in the literature regarding similar incidents. Krishnan VP et al. reported a case of PICC fracture and embolisation in the pulmonary artery, which required surgical removal.[27] Wortley et al. published a study in 2020 regarding the displacement of PICC following power injection of contrast media.[28] Out of 2045 PICC catheters in their study, only 1% of catheters had mal-position after power injection of contrast media, but no intervention was required, and catheters were self-corrected back to their original position after an average interval of 24-72 hours. No study has definitely opined regarding the safety of PICC for power contrast administration, though most of the studies recommend it can be used.[29]

We have only 2 chemo-ports in our study. The average dwell time was 101 days. The dwell time with chemo port is usually longer,with a reported dwell time of as long as two years.[30] The short dwell time in our study was because of premature removal due to

complications. One chemo-port was removed due to CLABSI (Candida albicans). The other chemo-port was removed as the tunnelled catheter got dislodged from the port and migrated to the right atrium. There was no hemodynamic compromise or dysrhythmia, but the patient had to undergo percutaneous removal of catheter fragments by a cardiologist. Dislodgement and migration of chemo-port catheter is a rare complication of uncertain aetiology and with potentially serious consequences.[31] Retrieval should be done by an experienced cardiologist or interventional radiologist.[32]

From this study, we opine that institutions with pediatric oncology facilities should have written policies for the selection and care of catheter devices. The age of the patient, duration of catheter need, type of drugs (chemotherapy and others), and availability of skilled and dedicated personnel for insertion and care are the factors that should be considered while choosing a catheter type.

Conclusions

Midline catheters are an acceptable alternative to PICC and CVC in a newly established pediatric oncology centre. Its use is likely to reduce the chances of CLABSI even though the incidence of non-serious complications like thrombophlebitis and leakage are more common. Midline is a good option for the anticipated intermediate duration of catheter need as the technique of insertion is relatively straightforward (even without USG guidance) and has fewer costs involved. Chemo-port has the longest dwell time and should be a preferred option when trained staff for its use is available.

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