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Utility & Challenges of Various Types of Central Venous Catheters in Pediatric Bone Marrow Transplant Patients-A Single Center Study

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ABSTRACT

Objective: This study aims to assess the utility and challenges of various available venous access options in pediatric transplant patients of our center.

Methodology: This retrospective study was carried out at bone marrow transplant center of Dr Akbar Niazi teaching hospital Islamabad. Data of bone marrow transplant patients with tunneled & non-tunneled CVCs during early transplant phase were collected from March 2018 to December 2023. The data were entered on SPSS version 2023 for analysis. The association between two categorical variables was assessed using Pearson's chi square and Fisher's exact test. P-value of <0.05 was considered significant.

Results: Out of 48 patients, 30 (62.5%) had tunneled-cuffed Hickman or Broviac central line whereas 18 (37.5%) had non-tunneled central line in the early transplant period. The indwelling period of tunneled CVC and non-tunneled CVP was 38.8±7.1 and 23±7.7 days with p-value of 0.001 respectively. Ooze from insertion site and infection was significantly more frequent in non-tunneled central line with p-value of 0.04 and 0.001 respectively. In case of infection in patients with tunneled central line, escalation to 2nd and 3rd line antibiotics was more frequent (p value 0.014). Tunneled central lines in 46.7% of the patients were removed at the time of discharge and did not require platelet transfusion cover due to stable platelet count of more than 20,000/µl. In cases of removal of tunneled central lines due to febrile neutropenia extensive coverage of single donor platelets (SDP) and/or random donor platelets (RDP), due to special precautions. The removal of non-tunneled central line was a bedside, ward procedure with or without random donor platelet coverage, depending upon clinical requirement.

Conclusion: For venous access in early transplant period both tunneled-cuffed and non-tunneled central lines can be used but special precaution of central line induced infection should be followed meticulously.

Key words: Antibiotic escalation, Bone marrow transplantation, Central venous catheter, Pediatrics.

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Introduction

Bone marrow transplantation (BMT) is an established treatment modality in pediatric hematology and oncology patients.[1,2] Central venous access is vital in HSCT for chemotherapy administration, blood transfusions, fluid management and frequent blood sampling. Tunneled and cuffed central venous catheter is recommended in pediatric patients but in low resource countries with constrained financial status and scarce healthcare professionals alternatives are explored.[3-5] Latest guidelines recommend ultrasound guided placement of central venous catheter over the surgical cut down method.[4,5] A local study was conducted on dialysis dependent patient which has shown the successful placement of tunneled central venous catheter by using

pre procedural ultrasound guided anatomical landmark measurement technique without fluoroscopic guidance.[6] Central Line Associated Blood stream Infection (CLASBI) is more common in Non-tunneled central venous catheter(CVC), as bacteria on the surface of the catheter migrate from exit site towards the intravascular space whereas fibrosis around the tunneled catheter prevents bacterial migration into the blood stream,[7] while catheter related Venous thromboembolism(VTE) is commonly seen in tunneled or PICC line.[8] Formation of a biofilm and micro thrombi in CVC can protect micro-organisms from antibiotics resulting in resistant organisms and use of broad spectrum parental antibiotics in these cases and further complicating the situation.[9]

Removal of cuffed central line during thrombocytopenic post-transplant phase can be associated with difficulty in securing homeostasis, if traction or cut down method is to be applied to overcome fibrosis, though in cases with no fibrosis removal even at low platelet count can be carried out uneventfully.[10] On the other hand non tunneled central lines are easily removed at the bedside of the patient on low platelet count.[11] In low resource settings, blind insertion and bedside removal of non-tunneled CVCs can serve the purpose of venous access during conditioning and early post-transplant phase.

Methodology

A retrospective study was conducted on patients of HSCT admitted in pediatric hematology oncology and BMT unit of Dr Akbar Niazi Teaching Hospital, using tunneled & non-tunneled central lines. Duration of study was from March 2018 to December 2023. Patients with peripheral intravenous cannulation or peripherally inserted central catheter (PICC) were excluded from study. Data related to patient characteristics (age, gender, indication for transplant), catheter characteristics (type, number of lumens, location of insertion) were entered on a specially designed performa. Moreover, data on complications during insertion/ dwell period/removal, dwell time, platelet count at the time of removal, platelet coverage during removal, antibiotic escalation during central line placement and after the removal of central line were also collected. Perspective of treating team (doctors and nurses) related to advantages and disadvantages of both types of central lines was collected by an interview. The data were entered on SPSS version 2023 for analysis. The mean, median and standard deviation were calculated through descriptive analysis. The association between two categorical variables was assessed using the Pearson's chi square and Fisher's exact test. P-value of <0.05 was considered significant.

Results

Among 48 patients, 41 were less than 10 years, and 7 were more than 10 years of age. Males were 32 (66.6%) and 16 (33.3%) were females. In most of the cases (45 /94%) cases, bone marrow transplant was done for Thalassemia major and only 3 (6%) cases were of Neuroblastoma. Out of 48 patients, 30 (62.5%) had tunneled-cuffed Hickman or Broviac central line whereas 18 (37.5%) had non-tunneled central line in the early transplant period. Table I shows characteristics of CVC lines. The indwelling period of tunneled CVC and non-tunneled CVP was 38.8±7.1 and 23±7.7 days respectively with p-value of 0.001. Ooze from insertion site and infection was significantly more in non-tunneled central line with p-value of 0.04 and 0.001 respectively (table II). In case of infection in patients with tunneled central line, escalation to 2nd and 3rd line antibiotics was more frequent (p value 0.014). In 46.7% of the patients, tunneled central line was removed at the time of discharge and did not require platelet transfusion cover due to stable platelet count of more than 20,000/µl (table III). In cases of removal of tunneled central line due to febrile neutropenia, extensive coverage by SDP and/or RDPs was given. The removal of non-tunneled central line was a bedside, ward procedure with or without RDP or SDP coverage depending upon clinical requirement. Table IV shows thematic analysis of qualitative data.

Table I: Characteristics of CVC lines.

Description		Numbers (Percentage)	
Catheter type	Tunneled CVC	30 (62.5)	
	Non tunneled CVL	18 (37.5)	
Number of lumens		Tunneled CVC	Non tunneled
	Double/Triple lumen	27 (90)	16 (88.8)
	Single lumen	03 (10)	02 (11.2)
Insertion location	Subclavian vein	30 (100)	14 (77.7)
	Jugular vein	00	04 (22.2)

Discussion

Central venous access is an essential requirement for transplant patients. The type of access can vary depending upon the availability of specialized services and expertise. In our study 62.5% of tunneled line was used and 44% of our patients were under 4 years of age, though we did not consider in our study but a study by Kleidon TM et al. has shown that central line multiple insertion attempts and failure is seen in young patients and with tunneled type of central line.[12] Centrally placed

lines are recommended for transplant purpose but at the same time transplant patients are immunocompromised and they are at increased risk of blood stream infection.[13] The blind percutaneous insertion of a non-tunneled central line in an external jugular vein or subclavian vein is a simple procedure which can be attempted without general anesthesia. So non tunneled central lines can be an alternative in pediatric transplant patients.[14]

Madabhavi I. et al reported that the types of complications are observed in a tunneled CVC (Hickman line) in a descending order were arrhythmias, infection, bleeding, pneumothorax, catheter blockage, and premature catheter removal.[15] We observed infection, blockage and difficulty in sampling in descending order among tunneled central line cases, and infection followed by ooze from the entry point in cases of non-tunneled central lines. Rate of CVL infection was more in patients with non-tunneled central line but need for escalation of antibiotics from 2nd to 3rd line antibiotics drugs was less as compared to tunneled cuffed central line. In the era of

Table II: Complications during dwelling period

Description		**Tunneled CVC** (n=30)	**Non tunneled CVC** (n=18)	**p-value**
Indwelling period in days (Mean ± SD)		38.8±7.1	23.8±7.7	0.001*
Complications during indwelling period n (%)	Difficulty in sampling	4 (13.3)	-	0.28
	Blockage	6 (20)	-	0.07
	Ooze from insertion site	-	3 (16.7)	0.047*
	Infection	09 (30)	15 (83.3)	0.001*
Antibiotic coverage before central line removal n (%)	No antibiotic	12 (40)	03 (16.6)	0.014*
	1st line antibiotics	02 (6.6)	07 (38.8)	
	2nd line antibiotics	12 (40)	08 (44.4)	
	3rd line antibiotics	04 (13.3)	00 (0)	
Antibiotic coverage after central line removal n (%)	No antibiotic	15 (50)	04 (22.3)	0.07
	1st line antibiotics	02 (6.6)	03 (16.6)	
	2nd line antibiotics	10 (33.3)	11 (61.1)	
	3rd line antibiotics	03 (10)	00 (0)	

Table III: Indication for removal and complication at the time of removal of central line

Description		**Tunneled CVC** n (%)	Non tunneled CVC n (%)	p-value
Indication for removal	At the time of discharge	14 (46.7)	02 (11.1)	0.03*
	Fever/Febrile Neutropenia	10 (33.3)	13 (72.2)	
	Blockage/ loss of function	05 (16.7)	02 (11.1)	
	Self-removal	01 (3.3)	00 (0)	
	Local swelling	00 (0)	01 (5.6)	
Complications at the time of removal	Bleeding/Oozing	02 (6.7)	01 (5.6)	1.0
	Fracture/dislodge	04 (13.3)	00 (0)	0.28
	Fibrosis	04 (13.3)	00 (0)	0.28
Platelet coverage at the time of removal	Single donor Platelet	03 (10)	01 (5.5)	0.007*
	Random donor Platelet	05 (16.6)	11 (61.1)	
	No platelet Coverage	22 (73.3)	06 (33.3)	
Platelet Count at removal	<20,000	10 (33.3)	11 (61.1)	0.15
	20,000 - 50,000	11 (36.6)	03 (16.6)	
	>50,000	09 (30)	04 (22.2)	

Table IV: Analysis of Qualitative data.

Data Extract		Codes	Themes
Tunneled CVC (n=30)	Non-Tunneled CVC (n=18)		
Ultrasound guided insertion need special equipment and expertise	Blind insertion can be done easily by anesthetist under General anesthesia	Requirement of expertise	Insertion and removal of Central line
High Cost (3 times) and need multiple visit and special preparation at the time of insertion and removal	Cost effective and easy to plan	financial and logistic impact	
Easy sampling and more secured i.e. less threat of dislodgment while handling	sampling in case of external jugular vein placement was positional as compared to subclavian	Utility of Central access	Efficiency of Central line according to types
Comfortable for patient	Patient not comfortable with placement in external jugular vein	Patient comfort	

emerging multidrug resistant micro-organisms, excessive use of broad-spectrum parental antibiotics to control blood stream infections during neutropenic phase can be futile. Measures to reduce introduction of infection at central line insertion and with handling can positively affect the rate of infection. Studies have shown that CVC type, number of lumens, dressing type, insertion vein, and being in the critical care unit were statistically significantly associated with central line associated blood stream infection (CLABSI) and sequential association of CLABI reduction was noticed with introduction of hand hygiene practices.[16]

The removal of the non-tunneled central line was less complicated and in 61 % of the cases it was removed uneventfully under 20,000 $x10^3$/µl platelet count with mostly under conveniently available random donor platelet cover. Whereas in 33% of cases of tunneled central line, removal was carried out at platelet count < 20,000 $x10^3$/µl. Single donor platelet units in most of the cases were used for the removal of tunneled central lines which is an expensive procedure. But recently a study by Marwah P et al has shown that removal of tunneled central line post-transplant pediatric patients can be done safely under 20,000$x10^3$/µl without platelet cover.[12] During removal of tunneled and cuffed central line fracture/dislodging was seen in 13.3% while fibrosis around cuff requiring dissection was seen in 13.3% cases. while non-tunneled central lines were removed mostly uneventfully by the BMT team in IPD. In one case of tunneled central line, fracture of the line followed by its removal by pulmonary angiography was carried out. No such complications were seen in the removal of non-tunneled central lines in our study. A case report by Ates U et al showed that such interventions were done in stuck tunneled central lines when indwelling period of the central line was between 12-24 months but in our study the mean duration of tunneled central line was only 38.8 ±7.1 days.[17]

A patient's psychological satisfaction while choosing venous access has been highlighted by Ryan C et al in their study.[18] It was found that tunneled CVC though is more secure with easy sampling and less threat of dislodgment but requires special equipment and expertise, whereas non-tunneled CVC insertion can be done easily by anesthetist under general anesthesia.

Conclusion

For venous access in early transplant period both tunneled-cuffed and non-tunneled Central line can be used but special precaution of central line induced infection should be followed meticulously.

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