Original Research Article

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Early complications of ultrasound guided central vein catheterization in children

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ABSTRACT

Background: Since mid-20th century Central Venous Catheter (CVC) has been in use. Cut-down was the initial approach that was followed by Seldinger method. Thereafter, anatomic land-mark has been recommended and finally it was switched to ultrasound (USG) guidance. In adults the lower complication and higher success rates of USG guided catheterization has been reported. However, in children, although it was accepted that USG guidance lowers puncture rates, increased success and decreased complication by USG was controversial.

Methods: Between 01/07/2014 and 31/12/2017 records of patients that were younger than five years old and that were undergone USG guided CVC placing have been extracted. The early complications due to catheterization was evaluated.

Results: A total 259 patients met our criteria. All of them have placed catheter successfully whereas mean puncture rate was 1.32. The 18.9% of them necessitated repetitive procedures of whom 44.9% (n=22) of them have been catheterized from the previous central line. Thrombosis was detected in only 2.7% (n=7) of them. Arterial puncture was noticed in four.

Conclusions: USG guided central vein catheterization is safe and reliable with lower complication. It could be speculated that lower puncture rates might have great influence on patency of vessels.

Keywords: Child, Central vein catheterization, Ultrasound

INTRODUCTION

Initially CVC placing has begun while mid-20th century via cut-down technic by Aubaniac.¹ Thereafter, Seldinger technique has been a new era for catheterization.⁴⁵ And it was followed by anatomic land-marc.⁶ However, surgeon has been still blind. Since 1970s when the USG guided catheterization was suggested, it has become most common in practice.⁵¹¹¹ Besides lots of studies promoting advantages of USG guidance, counter views are also reported in children.⁵ Furthermore, in children, USG guided CVC placing has only be recommended in NICE guidelines.⁵ According to the statistics of USA, five million CVC are placing annually and complications were reported in about 15% of them.¹²¹¹⁴ It has been

proven that USG guidance lowers the complications in adults. However, in children, although the USG guidance lowers the puncture rates, there is limited data about the influence of USG guided catheterization and complications. Therefore, in this study, the early complications of USG guided catheterization and success were evaluated.⁶

METHODS

After approval of institutional ethics committee (27/02/2018-34), between 1st July 2014 and 31st December 2017, records of patients that were undergone USG guided CVC placing have been extracted. CVC that were placed by other technics has been excluded.

Patients that were undergone real-time USG guided catheterization and younger than five-year-old has been included. Patient demographic data, the central vein [internal jugular vein (IJV), subclavian vein (SCV)], number of puncture, and complications such as hematoma, bleeding, thrombosis, pneumothorax, hemothorax have been conducted. Repetitive catheterizations were also extracted.

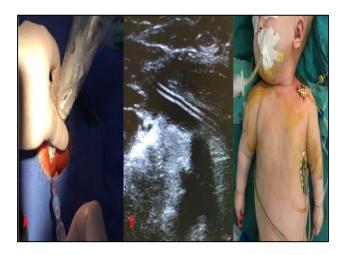


Figure 1: Supraclavicular approach to the LSCV (LSCV: Left Subclavian Vein).

Methodology of central line catheterization

Our approach has an algorithm for CVC placing whereas right IJV (RIJV) was the first line choice, left IJV (LIJV) was the second and supraclavicular left SCV (LSCV) was the last (Figure 1). 14,15

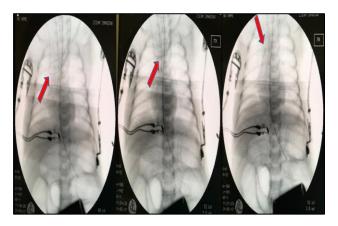


Figure 2: Fluoroscopic snapshot of catheter through LIJV, red arrow shows guidewire (LIJV: Left Internal Jugular Vein).

As children has a long life in front and also the higher puncture rates were found to be an underlying reason for vascular complications, we have allowed ourselves utmost three puncture attempts in a central vein. If unsuccessful after three attempts, surgeon switch to another location. Unless obtaining blood from needle and without observing arrhythmia after inserting guide wire, the puncture was not accepted as successful. The tip of the CVC was also confirmed by snapshot (Figure 2).

All patients were undergone catheterization under general anesthesia. After noticing central vein with USG before anesthesia, patients were given 20-30-degree Trendelenburg position and 20-30-degree contralateral head rotation to the preferred central line side. 3 fr CVC was placed to the patients lower than 2.5 kg, between 2.5-5 kg 4 fr was preferred and 5 fr to the patients that were higher than 5kg.

For real-time USG guidance 2-dimensional ultrasound [Vivid-i portable ultrasound, linear probe (12L-RS), GE Medical System Co. LTD-China] has been used.

RESULTS

Between 1st July 2014 and 31st December 2017, 340 patients, younger than five-year-old, was undergone CVC placing. And 259 of them was met our criteria. Mean age was 8 months and weights of patients were ranging between 700 gr to 19200 gr. 142 of them was male.

There was no failed process. The numbers of successful catheterization through RIJV, LIJV, RSCV and LSCV has been tabulated in the Table 1.

Table 1: The distribution of catheterized central veins by USG guidance and puncture rates.

	RIJV	LIJV	RSCV	LSCV	Totally
1 st puncture	161	8	3	10	182
2 nd puncture	33	6	2	5	46
3 rd puncture	9	5	0	1	15
Unknown	16	0	0	0	16
Totally	219	19	5	16	259

(USG: Ultrasound, RIJV: Right Internal Jugular Vein, LIJV: Left Internal Jugular Vein, RSCV: Right Subclavian Vein, LSCV: Left Subclavian Vein

In the study group, while 81.1% (n= 210) of patients had undergone single procedure, 18.9% (n= 49) of the rest have been necessitated re-insertion. Repetitive catheterization was necessitated due to many reasons such as prolonged treatment, taken out of catheter incidentally, thrombosis, infection etc. During the second catheterization of the 44.9% (n= 22) patients, it has been figured out that catheterization was performed from the previous central line at least once.

Out of seven patient thrombosis was not detected in which five of them (10.2%) had undergone long term TPN and repetitive procedure.

Even though USG guidance, in the group of patients that were undergone a single procedure, thrombosis was detected in two patients and in one of them more than

three punctures was determined. For the other one any reason was specified.

Any hematoma, bleeding, hemo/pneumothorax was detected. Arterial puncture was subjected in four, two of which were to the right carotid and the other was to the right subclavian artery. Interestingly the suturation of catheter was determined in a patient.

DISCUSSION

Invasive blood pressure monitoring, administrating chemotherapy, infusion of liquids and/or macromolecules and also ease of obtaining blood sample were all indications for CVC use in children. However, particularly in children, it also has drawbacks at the time of procedure and during long term of use. Bleeding, hematoma, thrombosis, arterial puncture, arrhythmia, pneumothorax/hemothorax are the early complications and infection, sepsis, thrombosis, vascular or cardiac perforation, migration of the catheter are the other complications of CVC. Besides mentioned controversies, due to patient comfort, its' use has been increased recently.

In adults, it has proven that the complication rates of catheterization were degreased after USG guidance.⁷ However, in children, although, lower puncture rates have been reported, there is no consensus about lower complication rates. Moreover, it was only recommended according to NICE guidelines owing to few data about USG guided catheterization in children.

According to literature, a variable range of successful catheterization, with variable age and weight of patients, has been reported. 10,19-22 Manlhiot et al. have reported 11% incidence of arterial or venous vessel thrombosis in pediatric cardiac surgery patients and also up to 14% arterial puncture, 6% pneumothorax have been noticed. Although our group has a wide range of patients, there was no failed procedure. Moreover, 1.5% of arterial puncture was seen in the study group whereas, it was 0.9% in RIJV group that was lower than the literature. Interestingly, we did not notice arterial puncture in the LSCV group. We believe that our stepwise approach with limited puncture rates plays an important role for our lower complication and higher success rates.²³ Over and above, Snell has mentioned that LSCV is lying more medially than RSCV. We believe that besides very little anatomic difference, it was adequate for visualization by USG. We also should state that, while visualizing the RSCV, we were not as much successful as LSCV. McGee et al. and Srisan et al. has stated that up to 20% of central vein catheterization complications were attributed to mechanical effects.^{24,25} Calvache et al. has stressed that more than three puncture has strong interest on vascular complications.¹⁵ Therefore, utmost three puncture has been set up as a rule while placing CVC. Results of the study has also encouraged us for the success of our clinical approach. On the other hand, 18.9% of patients

had undergone at least two or more catheterizations. And, in 44.9% of them, CVC was placed from previous central vein. In other words, it could be speculated that in the light of USG guidance and limited puncture rates vessels were damaged, as lower than as expected. We should state that in two patients, although initial attempt from RIJV was unsuccessful, they were undergone successful catheterization during second procedure through RIJV. Consequently, we believe that it was thanks to the limited puncture.

CONCLUSION

USG guided CVC placing is safe and reliable in children. The anatomic nuances of LSCV should be the underlying reason for better visualization and could be a choice in case of failed internal jugular veins. We believe that puncture rate is at the top of the list for vascular complications and limited puncture of our approach might played important role for decreasing the catheter related problems.

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