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Ultrasound-Guided Central Venous Cannulation in Neonates: A Comparison Between Introducer Needle and Cannula over the Needle Techniques

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ABSTRACT

Objective: To compare introducer needle technique versus cannula over the needle technique for guide-wire placement to perform successful central venous cannulation in neonates using ultrasonography

Study Design: Quasi-experimental study.

Place and Duration of Study: Department of Anaesthesia, Pak Emirates Military Hospital Rawalpindi Pakistan, from Feb 2020 to Jun 2021.

Methodology: A total of 78 neonates who required central venous cannulation under general anaesthesia were randomly divided into two equal groups, Introducer Needle Group, Group-I (n=39), and Cannula Over the Needle Group, Group-II (n=39). Primary outcome measure was success on first attempt and secondary outcomes were total number of attempts until success and duration of procedure. Procedure related complications were also recorded.

Results: Success on first attempt was much higher in Cannula over the Needle (CN) Group. Total number of attempts until successful cannulation were less in cannula over the needle (CN) group and time taken to perform successful cannulation was less in Cannula Over the Needle Group as compared to introducer needle group.

Conclusion: In neonates if cannula over the needle is used instead of introducer needle, success on first attempt is more likely. Moreover, number of attempts are reduced and less time is taken to perform successful procedure.

Keywords: Cannula, Central Venous Catheters, Newborn, Ultrasonography

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INTRODUCTION

Obtaining venous especially central venous access in small children is considered difficult due to small calibre of veins [1]. In neonates, insertion of central line is quite a challenge and requires skill and experience [2]. Population of hospitalized small children is increasing, and more and more neonates require insertion of central venous catheters. Common indications for central lines in neonates are poor peripheral access, use of total parenteral nutrition, fluid management, frequent blood sampling, central venous pressure measurement and major surgical procedures [3,4]. The procedure is technically difficult and not without potential complications like arterial puncture, haematoma formation, haemothorax, pneumothorax and thrombosis [5].

Previously land-mark technique was used for insertion of central lines but since last two decades use of ultrasound has gained popularity to improve the safety and quality of central line placement and to reduce the number of complications [6,7]. Every pediatric central line kit is provided with an introducer needle as well as a cannula over the needle for puncturing the vein and then inserting guide-wire. In introducer needle technique, needle is advanced till it enters the vein, blood is aspirated to confirm its presence inside the vein, syringe is detached carefully and guide-wire is gently threaded via the needle into the vein[8]. In cannula over the needle technique, cannula with needle is introduced into the vein, once it is inside vein, needle is removed and cannula is advanced further into the vein.

The aim of our study was to compare the introducer needle and cannula over the needle techniques in terms of success in first attempt, total number of attempts till success, time taken to complete the process and number of complications in neonates.

METHODOLOGY

The quasi-experimental study was carried out at Pak Emirates Military Hospital, Rawalpindi Pakistan, after approval from Ethical Review Committee (ERB number A/28/EC/370/2021). A sample of 78 neonates was computed through WHO sample size calculator keeping estimated patient population to be

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170 and population proportion of 7%[9]. Patients were selected by purposive sampling.

Inclusion Criteria: The neonates who presented for major surgery and neonates who were referred to Anaesthesia Department for insertion of central line, were included.

Exclusion Criteria: The neonates who had infection at site of cannulation and who already had functioning umbilical artery catheter were excluded.

The written informed consent from parents/ guardians was obtained. Three operators performed cannulations, with three experienced consultants and two senior registrars from our department. We randomly divided them into two equal groups (n=39 in each group); IN- Group-I: Introducer Needle technique, CN- Group-II: Cannula over Needle technique (Figure).

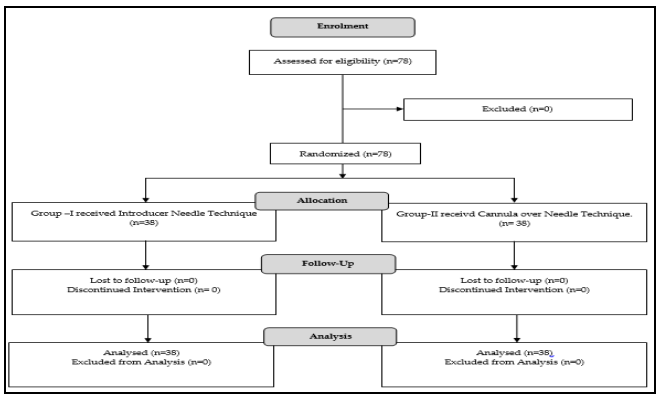

Figure: Patient Flow Diagram (n=78)

We attached routine standard monitoring and induced general anaesthesia with sevoflurane. When neonates became sufficiently deep enough, laryngeal mask airway was inserted. Neonates requiring surgery were intubated with a tracheal tube. Neonates were placed in Trendelenburg position, with the head slightly rotated to the left. A small size towel roll was placed under the shoulders for better neck position and exposure. Skin of neck was cleaned with povidone-iodine and draped with sterile disposable towels. Operator scrubbed and wore sterile gown, and gloves. We used 4.5 Fr, 6 cm, triple lumen central line (Vygon multicath3, Vygon GmbH & Co) in all patients.

In Group-I, a 21 G 40 mm introducer needle was used for vein puncture, once venous blood was aspirated, guide-wire was inserted. We confirmed guide-wire position inside vein by using ultrasound. Vein was then dilated by using 5 FR 62 mm vein dilator and then central line was inserted over the guide-wire. Guide-wire was then removed and all three lumens of central line were aspirated to confirm presence of venous blood and then flushed with saline. Central line was then stitched with proline and secured with transparent sterile dressing.

In Group-II, cannulation was performed using a 22 G 25 mm cannula, and after aspiration of venous blood, needle present inside the cannula (trocar) was removed and syringe was attached with cannula and venous blood was aspirated. Cannula was then gently pushed further in vein and guide-wire was inserted in it and confirmed by using ultrasound.

Chest X-ray was performed in all cases to identify central line tip position and to look for possible complications like haemothorax and pneumothorax. An observer recorded number of attempts till successful cannulation and central line access time. An attempt was defined as the time between needle entry into the skin and its removal. Access time was defined as time from first skin puncture till aspiration of venous blood from all lumens of central line. Complications like haematoma formation, haemothorax or pneumothorax were also recorded.

Statistical Package for Social Science (SPSS) version 20 was used for statistical analysis. Quantitative variables like age and weight were presented in the form of Mean±SD and range. The two groups were compared for age and weight using the Mann–Whitney U-test. The time taken for cannulation and the number of attempts were compared using the Student's t test. Statistical significance was taken at $p \leq 0.05$.

RESULTS

We included 78 neonates in this study who required central venous cannulation. The demographic data of the study population is summarised in Table-I. There were no statistically significant differences in baseline demographics between the groups (Table-I).

In CN Group (Group-I) 30 (76.9%) cases were cannulated on 1st attempt as compared to IN Group (Group-II) in which only 8 (20.5%) cases were cannulated in 1st attempt ($p<0.00006$) (Table-II).

In CN group (Group-II), 30 cannulations were done in 1st attempt, 5 in 2nd attempt, 3 in 3rd attempt and 1 in 4th attempt. In IN group (Group-I) 8 cannulations were done in 1st attempt, 3 in 2nd, 9 in 3rd, 11 in 4th, 6 in 5th and 2 in 6th attempt (Table-III).

Table-I: Demographic Data of Patients (n=78)

Parameters	Introducer needle Group-I (IN) n=39 (Mean ±SD)	Cannula over needle Group-II (CN) n=39 (Mean ±SD)	*p*-value
Age (days)	16(±5.947)	18.6(±5.82)	0.930
Weight (kg)	3.4(±0.483))	3.5(±0.491)	0.659
	Frequency n(%)	Frequency n(%)	
Gender Male/Female	19/20(%)	21/18(%)	-

Table-II: Success in First Attempt for both Interventions (n=78)

Success in First Attempt		Frequency (%
Intoducer Needle Group-I (IN)	No	31(79.5)
	Yes	8(20.5)
	Total	39(100)
Cannula Over Needle Group-II (CN)	No	9(23.1)
	Yes	30(76.9)
	Total	39(100)

Table-III: Number of Attempts taken for both Interventions (n=78)

Number of Attempts		Frequency (5)
Intoducer Needle Group Group-I (IN)	1	8(20.5)
	2	3(7.7)
	3	9(23.1)
	4	11(28.2)
	5	6(15.4)
	6	2(5.1)
	Total	39(100)
		Frequency (%)
Cannula over Needle Group Group-II (CN)	1	30(76.9)
	2	5(12.8)
	3	3(7.7)
	4	1(2.6)
	Total	39(100)

Therefore, total number of attempts were significantly less in CN group (Group-II) with $p<0.05$. As shown in Table-IV, mean time taken to complete the procedure in minutes was less in CN group as compared to IN group 24.95(±5.666) vs. 17.69(±5.57) with a $p<0.0003$. We did not record any complication related to procedure.

Table-IV: Duration of Procedure in Minutes (n=78)

	Mean (±SD)	*p*- value
Introducer Needle Group-I	24.95(±6.56)	<0.001
Cannula over Needle Group-II	17.69(±5.58)	

DISCUSSION

Central venous cannulation has become an essential part of modern pediatric clinical practice in a variety of situations. Before the use of ultrasound in anaesthesia practice, open surgical venous cut down was commonly performed in very small children by pediatric surgeons [10]. Today, because of its safety and versatility central venous access under ultrasound guidance has become "standard of care" in clinical practice[11]. It reduces the requirement of repeated venepunctures and also saves the vein for future use [12]. Anatomic variations have been reported in the relative positions of the internal jugular vein and carotid artery in children that are similar to those seen in adults [13]. Due to small and mobile veins in neonates repeated attempts leads to haematoma formation which makes it difficult for successful cannulation in next attempts[14]. Moreover, number of complications increase with the number of attempts. Therefore, success at first attempt is important to increase the chances of overall success in cannulation and reduce the number of complications [15].

Fernando Montes-Tapia and colleagues [16]studied the safety and efficacy of ultrasound guided central venous cannulation in low birth weight neonates (<2.5 kg). Success rate of RIJV cannulation was 94%. First attempt success rate was only 50% of cases and in 5 attempts, they reached success rate of 95.7%. Their maximum numbers of attempts were 8 to achieve successful cannulation and their procedure duration was [16].8(10–40) minutes. A venous hematoma occurred in 5% of cases. Saleh Abdelaziz Hamouda and colleagues[17] compared central venous cannulation in RIJV with introducer needle and cannula over the needle technique in 120 neonates. In agreement with our study, they found significantly higher first attempt success in cannula over needle in age subgroups of less than 30 days (75 vs. 22.2%). They also recorded a smaller number of attempts in cannula technique in age subgroups of less than 30 days (Mean, 1.75 vs. 4.77).

Song and colleagues [18] studied central line insertion by Seldinger (introducer needle technique) and modified Seldinger technique (cannula over needle) in 120 neonates. Their results are comparable to our study. They found modified Seldinger (cannula technique) superior to Seldinger (needle technique) in terms of successful guide wire insertion on first attempt (95% vs 75%). Successful central venous cannulation on first attempt was also higher in the modified Seldinger group than in the Seldinger group (83% vs 65%).

LIMITATIONS OF STUDY

Anaesthetists who had experience of using ultrasound and pediatric central lines performed the procedure

therefore our results cannot be applied to physicians who are unfamiliar with ultrasound-guided central venous cannulation in neonates.

CONCLUSION

In neonates if cannula over the needle is used instead of introducer needle, success on first attempt is more likely. Moreover, number of attempts are reduced and less time is taken to perform successful procedure.

Conflict of Interest: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AR: & SM: Study design, drafting the manuscript, data interpretation, critical review, approval of the final version to be published.

KM: & SAMR: Data acquisition, data analysis, approval of the final version to be published.

AH: & AG: Critical review, concept, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

REFERENCES

1. Lau CS, Chamberlain RS. Ultrasound-guided central venous catheter placement increases success rates in pediatric patients: A Meta-Analysis. Pediatr Res 2016: 80(2); 178-184. https://doi.org/10.1038/pr.2016.74
2. Oulego-Erroz I, Gonzalez-Cortes R, Garcia-Soler P. Ultrasound-guided or landmark techniques for central venous catheter placement in critically ill children. Intensive Care Med 2018: 44(1); 61-72. https://doi.org/10.1007/s00134-017-4985-8
3. Shime N, Hosokawa K, MacLaren G. Ultrasound Imaging Reduces Failure Rates of Percutaneous Central Venous Catheterization in Children. Pediatr Crit Care Med 2015: 16(8); 718-725. https://doi.org/10.1097/PCC.0000000000000470
4. Bhatt S, Dahat A, Jain N, Nayak U, Patel V. Indications and complications of central venous catheterization in critically ill children in intensive care unit. Nat J Med Res 2012: 2(1); 85-88.
5. Calvache JA, Rodriguez MV, Trochez A, Klimek M, Stolker RJ, Lesaffre E, et al. Incidence of mechanical complications of central venous catheterization using landmark technique. J Intensive Care Med 2016: 31(6); 397-402. https://doi.org/10.1177/0885066614541407
6. Zanolla GR, Baldisserotto M, Piva J. How useful is ultrasound guidance for internal jugular venous access in children? J Pediatr Surg 2018: 53(4); 789-793. https://doi.org/10.1016/j.jpedsurg.2017.08.010
7. Henrique de Souza T, Brandão MB, Santos TM. Ultrasound guidance for internal jugular vein cannulation in PICU: a randomised controlled trial: Archives of Disease in Childhood BMJ 2018:103(10);952-956. https://doi.org/10.1136/archdischild-2017-314568
8. Ates U, Derme T, Yilmaz Y. Ultrasound guided percutaneous central venous catheters in neonatal intensive care unit. Turk. J. Pediatr 2018:60(5):476-479. http://doi.org/10.24953/turkjped.2018.05.002
9. Hussain S, Asghar, Sabir M, Chattha M, Tarar S H, Mushtaq R, et al. Prevalence and pattern of congenital malformations among neonates in the neonatal unit of a teaching hospital. J Pak Med Assoc 2014:64(6);629-634
10. Sabouneh R, Akiki P, Al Bizri A, El Helou S, Zeidan S, Al Hamod D, et al. Ultrasound guided central line insertion in neonates: Pain score results from a prospective study. J Neonatal Perinatal Med. 2020;13(1): 129-134. http://doi.org/10.3233/NPM-180205
11. Naik VM, Mantha SSP, Rayani BK. Vascular access in children. Indian J Anaesth 2019;63(9):737-745. http://doi.org/10.4103/ija.IJA_489_19
12. Scott-Warren V, Morley R. Paediatric vascular access. Br J Anaesth 2015:(4);199–206. https://doi.org/10.1093/bjaceaccp/mku050
13. Rey C, Alvarez F, De La Rua V, Medena A. Mechanical complications during central venous cannulations in pediatric patients. Intensive Care Med 2009;35(8): 1438-1443. https://doi.org/10.1007/s00134-009-1534-0
14. Neto EPS, Grousson S, DufloF, Tahon F,Mottolese C, Dailer F, et al. Ultrasonographic anatomic variations of the major veins in paediatric patients. Br J Anaesth 2014:112(5);879–884. https://doi.org/10.1093/bja/aet482
15. Song IK, Lee JH, Kang JE. Comparison of central venous catheterization techniques in pediatric patients: needle vs angiocath. Paediatr Anaesth 2015;25(11): 1120-1126. https://doi.org/10.1111/pan.12726
16. Tapia FM, Tamez AR, Esquival IC, Arroya IB, Garduno AH, Balderrama IR. Efficacy and safety of ultrasound-guided internal jugular vein catheterization in low birth weight newborn. J Pediatr Surg 2016:51(10);1700-1703. https://doi.org/10.1016/j.jpedsurg2016.05.014
17. Hamouda SA, Hashem AE, Okasha MAA. Ultrasound-guided thin-wall needle technique versus cannula-over-needle technique in internal jugular vein catheterization in infants. Anaesth Intensive Care Med 2019:6(1);56–63. https://doi.org/10.4103/roaic.roaic_102_17
18. Song IK, Kim EH, Lee JH, Jang YE, Kim HS, Kim JT. Seldinger vs modified Seldinger techniques for ultrasound-guided central venous catheterisation in neonates: a randomised controlled trial. Br J Anaesth 2018:121(6);1332-1337. https://doi.org/10.1016/j.bja.2018.08.008