Open Access

Original Article

A Comparison of Palpation Technique versus Ultrasound-Guidance for Arterial Line Placement by Residents in a Teaching Institution

Taimur Azam Khan, Syed Qasim Ali Shah, Muhammad Mohsin Riaz, Osama Abdul Mateen, Mirza Hamid Beg, Muhammad Huzaifa Sharif

Combined Military Hospital/National University of Medical Sciences (NUMS), Rawalpindi Pakistan

ABSTRACT

Objective: To compare the ease of placement of arterial catheters using palpation versus ultrasound guidance under aseptic measures.

***Study Design*:** Quasi-experimental study.

Place and Duration of Study: Combined Military Hospital, Rawalpindi Pakistan, from Feb to Aug 2022.

***Methodology*:** Patients of either gender, aged 18 to 90 years presenting to a paranesthesia clinic that required intra-arterial blood pressure monitoring were included in the study. After induction, under General Anaesthesia, arterial lines were placed following an aseptic technique using ultrasound or palpatory method; in Group-U (ultrasound) or Group-P (Palpation), respectively. Demographic variables of the patient along with hemodynamic readings and success rate at first or multiple attempts, along with the total time of cannulation, were recorded.

Results: Out of the total 74 patients, 59(79.7%) patients belonged to ASA-1 Grade, and 15(20.3%) patients in ASA-2 Grade. The mean age of the patients was 48.3±16.3, while mean BMI was 25.42±2.8kg/m^2. In Group-P, the first-pass success was achieved in 19(51.4%) patients as compared to 32(86.5%) in Group-U when ultrasound was used (p<0.05).

Conclusion: The success rate in placing an arterial line using ultrasound was significantly greater than the conventional palpatory method. Therefore, ultrasound should be a preferred modality during intra-arterial line placement.

Keywords: Cannulation, Palpation, Ultrasound.

How to Cite This Article: *Khan TA, Shah SQA, Riaz MM, Mateen OA, Beg MH, Sharif MH. A Comparison of Palpation Technique versus Ultrasound-Guidance for Arterial Line Placement by Residents in a Teaching Institution. Pak Armed Forces Med J 2022; 72(6): 2147-2150. DOI: https://doi.org/10.51253/pafmj.v72i6.9252*

INTRODUCTION

Arterial cannulation is a well-known invasive procedure performed in operating rooms and intensive care units. It is frequently done in patients requiring repeated blood sampling and hemodynamic monitoring.[1] Multiple sites are available for arterial cannulation. However, the radial artery is usually preferred due to its superficial course with consistent anatomy and low complication rates, such as permanent ischemic complications (0.09%).[2,3] How-ever, cannulation is generally trickier in the pediatric population with the prolonged time required and multiple attempts at times.[4] Posterior tibial artery is considered an acceptable alternative to radial artery cannulation in the pediatric age group.[5] Complications commonly associated with arterial cannulation nerve injury are hematoma, infection and vasospasm.[6,7] However, these complications are considerably reduced by the efficient use of ultrasound for arterial cannulation rather than the palpation method, a point proved by multiple studies.[8,9]

Ultrasound can be used in two orientations with their specific advantages and disadvantages. One of these is the short axis (out of plane) technique which provides better visualization and appreciation of vessel and surrounding structures. On the other hand, in the long axis (in the plane) approach, the needle shaft is visible throughout the course.[10]

The rationale of this study was to ascertain the improvement in success rates of first-attempt cannulation of the radial artery using ultrasoundguided dynamic needle tip positioning technique in adult patients compared with the palpation technique.

METHODOLOGY

This quasi-experimental study was conducted at Combined Military Hospital, Rawalpindi Pakistan, from February to August 2022 after acceptance and approval from the Ethical Committee (ERB No. 256).

The sample size was calculated using the WHO calculator utilizing the hypothesis test for two population proportions with a significance level of 5%, 80% power of the test, the rate of successful intra-arterial catheter placement using ultrasound versus palpatory technique was 83% 1 and 48% 1, respectively. The calculated sample size was 64. Patients through a lottery method were divided into two groups, i.e.,

Correspondence: Dr Taimur Azam Khan, Department of Anesthesiology, Combined Military Hospital, Rawalpindi, Pakistan

Received: 08 Sep 2022; revision received: 16 Oct 2022; accepted: 19 Oct 2022

Group-P (palpation technique) and Group-U (ultrasound technique), with 37 patients assigned in each group.

Inclusion Criteria: Patients of either gender with age ranging from 18 to 90 years presenting to a paranesthesia clinic that required intra-arterial blood pressure monitoring were included in the study.

Exclusion Criteria: Patients with history of sepsis, positive Allen's test, planned for plastic surgeries involving upper limbs or incarcerated patients were excluded from the study.

During pre-anesthesia, after obtaining a detailed history, performing the systemic examination and assessing laboratory investigations, patients who required arterial line placement during the operative procedure were enrolled on the study.

The procedure was explained to every patient, and written informed consent was obtained. Nil per oral strategy was followed per the institutional protocol, and the patient was shifted to the operation theatre on the day of surgery. Patients were shifted to the operation theatre table, and monitors, including a non-invasive blood pressure cuff, pulse oximetry probe, electrocardiography electrodes and temperature probes, were attached. Standard anaesthesia induction was done after recording the baseline hemodynamic parameters, and the right or left radial artery was selected as per the attending anaesthetist for cannulation. The patient's wrist was placed on arm support and in a mild extended position by using a crepe bandage under the wrist. Sterile measures were taken, and an asepsis of the area to be cannulated was done before performing the procedure. A timer was used at the start of the line placement and stopped at the time of confirmed placement in the radial artery. In Group-P, palpatory technique was used using the tip of the index finger to locate the location and course of the artery under sterile technique; however, in Group-U ultrasound machine SonoSite (M-Turbo) was used. Of plane, the approach was utilized by using a straight probe of the ultrasound machine to visualize and cannulate the radial artery. In both procedures, an arterial catheter of 20 gauge was used. Recorded variables included the demographic data of each patient, including age, gender, ASA, body mass index, mean arterial pressures (before and after the procedure), success on the first attempt, the overall success of cannulation and total time taken for cannulation in seconds.

Statistical Package for Social Sciences (SPSS) version 25.0 was used for the data analysis. The categorical variables were represented as frequency and percentage, whereas the mean and standard deviation were calculated for continuous variables. The mean values were compared using independent sample t-test among groups. The significance value of $p \leq 0.05$ was considered significant.

RESULTS

Out of the total 74 patients, the number of male participants in Group-P was 20(54.10%) and 22 (59.46%) in Group-U, while females from both groups were 17(45.95%) and 15(40.54%), respectively. 59 (79.7%) participants belonged to ASA-1 Grade, and 15(20.3%) patients had ASA-2 Grade. Gender and ASA distribution of the patients. The mean age of the patients was 48.3±16.3 years, while BMI was 25.42±2.80 kg/m^2 shown in Table-I. In Group-P the first pass success was achieved in 19(51.4%) patients as compared to 32(86.5%) in Group-U when ultrasound was used. The first pass success, overall success rate, and mean cannulation time also revealed significant results when ultrasound was used (a *p*-value of <0.05) in Table-II.

Table–I: Clinical and Demographic Distribution of Patients (n=74)

Variables	Group-P Mean±SD (n=37)	Group-U Mean±SD (n=37)	
Age	40.46±12.68 years	36.59±13.81 years	
BMI	25.70±2.97 Kg/m2	25.14±2.51 Kg/m2	
ASA Grades	ASA-I	30(81.10%)	29(78.40%)
	ASA-II	07(18.90%)	08(21.60%)
Gender	Male	20 (54.05%)	22(59.46%)
	Females	17(45.95%)	15(40.54%)

Table–II: First Pass success, Overall success, and Total Cannulation Time (n=74)

Variables	Group-P (n = 37)	Group-U (n =37)	*p*-value
First Pass success	19(51.40%)	32(86.50%)	0.001
Overall success (first 5mins)	24(64.90%)	35(94.60%)	0.001
Total Cannulation time (sec)	117.08±44.52	84.32±23.2	0.001

DISCUSSION

This study was designed to evaluate the effectiveness of ultrasound machines in maintaining arterial catheters versus the standard blind palpatory technique. Results revealed a prominent role of ultrasound compared with a blind palpatory technique of vessel cannulation. In addition, it decreases the chances of failure and reduces the mean cannulation

time in seconds, significantly impacting monitoring patients in the operation theatre during surgical procedures.

Radial and ulnar arteries are the most important vessels perfusing the hands with comparatively easy access to cannulate by anesthesiologists.[11] Before performing cannulation, Allen's test is done to assess the collaterals of the hand to prevent ischemia of the hand in case of artery puncture during cannulation or thrombosis. Perfusion assessment can also be done using ultrasound before the procedure.[12,13] Various techniques are used to cannulate the artery, including ultrasound or a palpatory technique with or without a guidewire. A study showed an increased success rate of 76% in patients using a palpatory method of cannulation when guidewire was used compared to a non-guidewire technique.[14]

Posterior tibial or dorsalis pedis arteries are the usual alternatives to the radial artery for cannulation with a diameter large enough to allow easy catheter placement. Kim *et al.* found that the success rate of the cannulating posterior tibial artery, compared to the radial artery, was the same when ultrasound was used for the procedure.[7] Comparing Dynamic needle tip positioning and the angle-distance technique, it was found that using the former technique increased the cannulation time. However, the puncture rate was reduced, making it favourable compared to the latter.[15]

Like the results of our study, Anantasit *et al.* found that the time to cannulation was decreased however the success rate was increased in patients when ultrasound was used with a success rate of 2.03% compared to the success rate of 4% when traditional palpation was done for placing the arterial catheters.[8] In another study, similar results proved the superior role of the ultrasound technique with a 91% success rate compared to the palpatory method yielding only a 57% success undergoing cannulation of the radial artery.[16]

Comparable to the present study, another research work in which trainee anaesthetists were able to place the catheter successfully in 36 out of 40 patients when ultrasound was used vs 28/40 successful line placements via palpatory approach.[17]

In another study, the optimized ultrasonic localisation system was used, which improved the success rate of cannulating arteries compared to a normal ultrasound. The small diameter and smaller surface area in the pediatric age group pose a great challenge in placing intraarterial catheters in this age group.[18] To decrease the failure rate and complications related to arterial line procedures, nitroglycerine drug was used before puncture. This showed a positive effect by causing arterial dilation and improvement of vision while decreasing the rate of complications in children. Hence our study was conclusive, proving the beneficial effect of using ultrasound to place an arterial line under vision with increased chances of correct placement and decreased rate of failure.

CONCLUSION

Better chances of correct placement during initial attempts and overall success with a decreased total time of cannulation makes ultrasound a preferred modality compared to the conventional palpation technique in placing arterial line catheters in our study population.

Conflict of Interest: None.

Author's Contribution

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

TAK & SQAS: Conception, study design, drafting the manuscript, approval of the final version to be published.

MMR & OAM: Data acquisition, data analysis, data interpretation, critical review, approval of the final version to be published.

MHB & MHS: Critical review, 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. Kiberenge RK, Ueda K, Rosauer B. Ultrasound-Guided Dynamic Needle Tip Positioning Technique Versus Palpation Technique for Radial Arterial Cannulation in Adult Surgical Patients: A Randomized Controlled Trial. Anesth Analg 2018; 126(1): 120-126. doi: 10.1213/ANE.0000000000002261.
2. Liu L, Tan Y, Li S, Tian J. "Modified dynamic needle tip positioning" short-axis, out-of-plane, ultrasound-guided radial artery cannulation in neonates: a randomized controlled trial. Anesth Analg 2019; 129(1): 178-183.
3. Brzezinski M, Luisetti T, London MJ. Radial artery cannulation: a comprehensive review of recent anatomic and physiologic investigations. Anesth Analg 2009; 109(6): 1763-1781.
4. Jang YE, Kim EH, Lee JH, Kim HS, Kim JT. Guidewire-assisted vs. direct radial arterial cannulation in neonates and infants: A randomised controlled trial. Eur J Anaesthesiol 2019; 36(10): 738-744. doi: 10.1097/EJA.0000000000001064.
5. Kim EH, Lee JH, Song IK, Kim JT. Posterior Tibial Artery as an Alternative to the Radial Artery for Arterial Cannulation Site in Small Children: A Randomized Controlled Study. Anesthesiology 2017; 127(3): 423-431. doi: 10.1097/ALN. 00001774.
6. Bai B, Tian Y, Zhang Y, Yu C, Huang Y. Dynamic needle tip positioning versus the angle-distance technique for ultrasound-guided radial artery cannulation in adults: a randomized controlled trial. BMC Anesthesiol 2020; 20(1): 231-135.

7. Kim SY, Kim KN, Jeong MA, Lee BS, Lim HJ. Ultrasound-guided dynamic needle tip positioning technique for radial artery cannulation in elderly patients: A prospective randomized controlled study. PLoS One 2021; 16(5): e0251712. doi: 10.1371/journal.pone.0251712.
8. Anantasit N, Cheeptinnakorntaworn P, Khositseth A, Lertbunrian R, Chantra M. Ultrasound Versus Traditional Palpation to Guide Radial Artery Cannulation in Critically Ill Children: A Randomized Trial. J Ultrasound Med 2017; 36(12): 2495-2501. doi: 10.1002/jum.14291.
9. Wang J, Lai Z, Weng X, Lin Y, Wu G, Su J, et al. Modified long-axis in-plane ultrasound technique versus conventional palpation technique for radial arterial cannulation: A prospective randomized controlled trial. Medicine (Baltimore) 2020; 99(2): e18747. doi: 10.1097/MD.0000000000018747.
10. Bhattacharjee S, Maitra S, Baidya DK. Comparison between ultrasound guided technique and digital palpation technique for radial artery cannulation in adult patients: An updated meta-analysis of randomized controlled trials. J Clin Anesth 2018; 47: 54-59. doi: 10.1016/j.jclinane.2018.03.019.
11. Gopalasingam N, Hansen MA, Thorn S. Ultrasound-guided radial artery catheterisation increases the success rate among anaesthesiology residents: a randomised study. J Vasc Access 2017; 18(6): 546-551. doi: 10.5351456145601/ jva.5000702.
12. Nam K, Jeon Y, Yoon S, Kwon SM, Kang P, Cho YJ, et al. Ultrasound-guided radial artery cannulation using dynamic needle tip positioning versus conventional long-axis in-plane techniques in cardiac surgery patients: a randomized, controlled trial. Minerva Anestesiol 2020; 86(1): 30-37.
13. Takeshita J, Yoshida T, Nakajima Y, Nakayama Y, Nishiyama K, Ito Y, et al. Superiority of Dynamic Needle Tip Positioning for Ultrasound-Guided Peripheral Venous Catheterization in Patients Younger Than 2 Years Old: A Randomized Controlled Trial. Pediatr Crit Care Med 2019; 20(9): e410-e414. doi: 10.1097/PCC.0000000000002034.
14. Xiao Q, Xu D, Zhuang S. Effect of wrist dorsiflexion on ultrasound-guided radial artery catheterisation using dynamic needle tip positioning technique in adult patients: a randomised controlled clinical trial. Emerg Med J 2021; 38(7): 524-528. doi: 10.1136/emermed-2020-209504.
15. Wu G, Chen C, Gu X, Yao Y, Yuan D, Lv J, et al. Ultrasound-Guided Dynamic Needle-Tip Positioning Method Is Superior to Conventional Palpation and Ultrasound Method in Arterial Catheterization. J Clin Med 2022; 11(21): 6539. doi: 10.3390 /jcm11216539.
16. Zhefeng Q, Luo C, Zhang L, Li X, He H, Chi P. Application of Optimized Ultrasonic Localization System for Radial Artery Puncture by Intern Doctors: A Randomized Trial. Med Sci Monit 2019 ; 25: 1566-1571. doi: 10.12659/MSM.913044.
17. Quan Z, Zhang L, Zhou C, Chi P, He H, Li Y, et al. Acoustic Shadowing Facilitates Ultrasound-guided Radial Artery Cannulation in Young Children. Anesthesiology 2019; 131(5): 1018-1024. doi: 10.1097/ALN.0000000000002948.
18. Jang YE, Ji SH, Kim EH, Lee JH, Kim HS, Mossad EB, et al. Subcutaneous Nitroglycerin for Radial Arterial Catheterization in Pediatric Patients: A Randomized Controlled Trial. Anesthesiology 2020; 133(1): 53-63. doi: 10.104544556456497/ALN. 0000000000003308.