



ORIGINAL ARTICLE

Comparison between ultrasound guided and palpatory method for radial artery Catheterization.

Sumayya Tariq¹, Muhammad Omar Afzal²

Article Citation: Tariq S, Afzal MO. Comparison between ultrasound guided and palpatory method for radial artery Catheterization. Professional Med J 2022; 29(11):1637-1643. <https://doi.org/10.29309/TPMJ/2022.29.11.7004>

ABSTRACT... Objective: To compare ultrasound guided and palpatory method of radial artery Catheterization in terms of number of attempts, total time required, frequency of catheterization in first attempt and haematoma formation after the procedure. **Study Design:** Randomized Control Trial. **Setting:** Intensive Care Units of Jinnah Burn and Reconstructive Surgery Center Lahore and Sharif Medical City Hospital. **Period:** June to December 2021. **Material & Methods:** 126 patients were included using nonprobability purposive sampling and divided into group A: ultrasound, B: palpatory group. Number of attempts, total time, successful 1st attempt and presence of haematoma was recorded and analyzed to compare outcome. **Results:** In 85.7% patients of group A, catheterization was done in first attempt while 74.6% in group B. In group A, the mean number of attempts was 1.14 ± 0.35 and 1.29 ± 0.52 in group B ($p=0.08$). Haematoma rate was 12.7% in group A while 22.2% in B. Mean total time was 71.0 ± 26.4 minutes in group A and 95.5 ± 62.3 in group B. **Conclusion:** Ultrasound guided radial artery catheterization is better than the palpatory method, particularly in middle aged patients.

Key words: Palpatory Method, Radial Artery Catheterization, Ultrasound Guided.

INTRODUCTION

Vital signs monitoring is an integral part of unstable and high-risk patients in intensive care unit (ICU) and theatres. Accurate measurement of blood pressure is critical in assessment of patients in these settings to start a lifesaving intervention. Measuring blood pressure through invasive intra-arterial monitoring is more accurate and gives beat to beat readings. Arterial catheterization is also utilized for frequent blood sampling for routine tests and arterial blood gases analysis in ICUs.¹ Radial artery is selected as first choice due to its superficial location and the collateral blood supply of the hand from ulnar artery.²

Ultrasound is a new modality that has countless applications in medical sciences. It is now a days frequently used to guide arterial catheterization enabling direct visualization of the arterial lumen and gives real time images of the catheterization. It is acclaimed to decrease total time and

number of attempts needed for catheterization, and also increases the likelihood of successful catheterization in first attempt.^{3,4} In two studies ultrasound increased the chances of successful first attempt, with one study comparing groups of 40 patients the difference was 88% against 70% for palpatory method ($p=0.027$). Yet one can deduct from the published data that the difference was reported as non-significant, 72% versus 64% in another study ($p=0.39$).^{4,5,6} The mean time required for catheterization was 64.5 ± 10.3 sec using ultrasound guidance while 150.8 ± 20.6 sec in palpatory method group ($p=0.005$), yet contradictory findings were noted in a local study, with 35.6 ± 17.4 sec in ultrasound versus 34.9 ± 19.4 sec in palpatory method group ($p=0.882$).^{4,7} There was also difference in published literature, with regards to mean number of attempts, e.g. 1.2 ± 0.7 in ultrasound versus 2.2 ± 0.8 attempts in palpatory method group ($p=0.001$) in total of 60 patients, as compared to 1.47 ± 1.1 versus 1.53

1. MBBS, FCPS (Anesthesiology), Senior Registrar, Sharif Medical City,
2. MBBS, FCPS (Plastic Surgery), Senior Registrar, Jinnah Center, Lahore.

Correspondence Address:
Dr. Muhammad Omar Afzal
Jinnah Center, Lahore.
dromarplasticsurgeon@gmail.com

Article received on: 02/02/2022
Accepted for publication: 01/08/2022

± 0.94 ($p=0.802$) in another, analyzing groups of 30 patients.^{7,8} There was scarcity of published literature directly comparing rate of haematoma formation related to either technique. Ultrasound guided technique was superior in a study, where rate of hematoma formation was 5.1% versus 25.4% ($p < 0.01$).⁹ But in a case series analyzing palpatory method, haematoma occurred in only 13% patients.¹⁰ Thus the advantage of ultrasound guided catheterization over palpatory method was not clearly established. There was not only paucity of local studies, but they also failed to replicate the results of international studies.

Although results demonstrating advantage of ultrasound technique on above mentioned variables are inconsistent, there are areas where it was found to be clearly superior over palpatory method. For example, in pediatric and obese patients it increased the rate of success and decreased the number of complications.⁸ Patients who presented with circulatory collapse, palpation of radial pulse was nearly impossible, but it was found that ultrasound guided attempts were successful by visualizing specific anatomic landmarks to locate radial artery.¹¹ Another study found that even junior anesthetists were not only quick to learn ultrasound guided arterial catheterization, but the success rate was higher as compared to palpatory method in the hands of a novice.¹²

Ultrasound guidance can be performed using either a short-axis (out-of-plane) or a long-axis (in-plane) approach to visualize the needle as it is advanced toward the radial artery, the latter being associated with more successful attempts.¹³

The rationale of our study was to compare the two techniques as there was variable evidence of one being clearly superior to the other, in the face of theoretical advantages of ultrasound. We did this comparative study so that the efficacy of either could be established over the other and thus, the technique be adopted with confidence, rendering better care for the patients.

MATERIAL & METHODS

This randomized controlled trial was done

simultaneously at intensive care unit (ICU) of Jinnah Burn and Reconstructive Surgery Center Lahore and intensive care unit of Sharif medical city hospital from June to December 2021. After approval from respective ethical review boards (1621-05-21), non-probability purposive sampling technique was used to include 126 patients, divided into two groups. We included patients between age twenty and fifty years of either gender who were admitted in ICU and needed arterial catheterization due to labile blood pressure, anticipated hemodynamic instability, titration of vasoactive drugs or frequent blood sampling. We excluded patients who had cord-like calcified arteries, circulatory collapse with no palpable peripheral pulses, obese patients with BMI > 35, had previous attempts of arterial catheterization on the same side, dominant radial artery on Allen's test, trauma or hardware used on the same side, bleeding / clotting disorder.

In group A were the patients in whom ultrasound guided catheterization was done, while in group B palpatory method was used. Number of attempts, total time required, whether first attempt was successful and presence / absence of haematoma after insertion were documented. Mean and standard deviation were calculated for numerical variables like age, number of attempts and total time required. Frequency and percentages were calculated for qualitative variables like gender, presence of haematoma and catheterization in first attempt. Data was stratified according to age, gender and BMI. Post stratification chi-square test was applied for proportions like hematoma formation and catheterization in first attempt and p value taken as ≤ 0.05 , to determine whether the use of ultrasound technique was more effective than palpatory method.

Technique of Catheterization

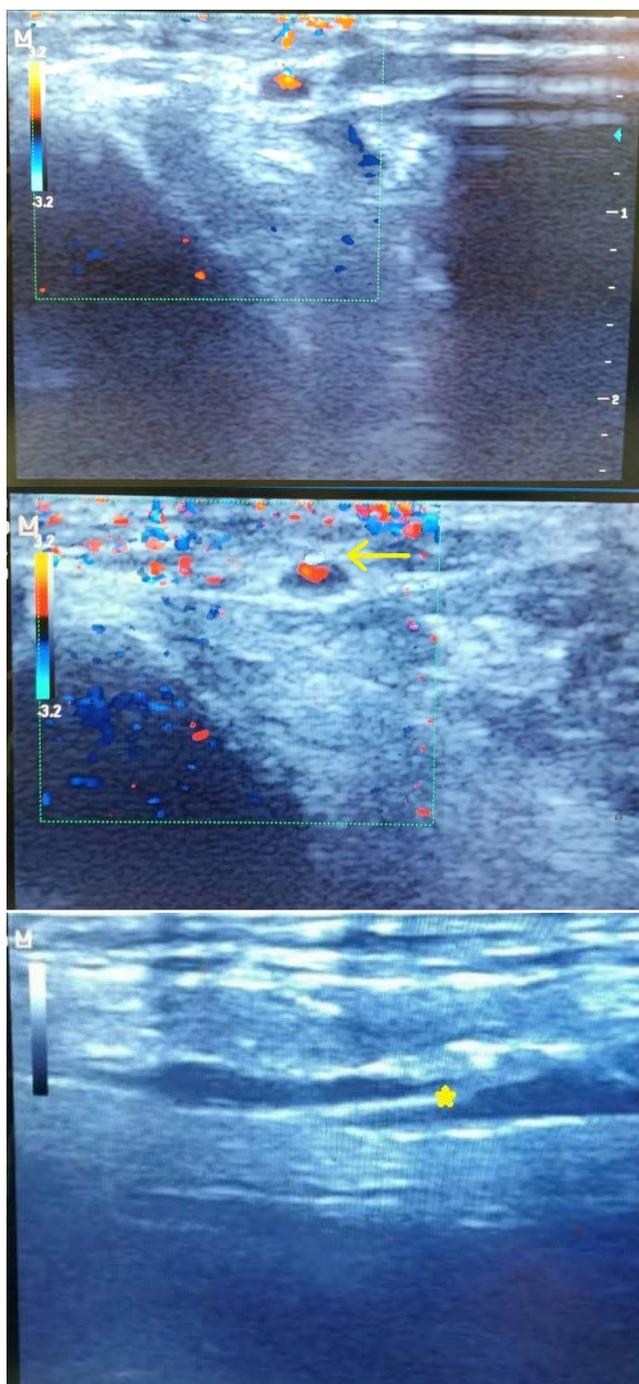
A total of 126 consecutive patients were enrolled for the study after fulfilling the selection criteria. After informed consent subjects were randomly assigned through a computer-generated simple randomization to either the ultrasound group (Group A) or to the palpatory group (Group B). Informed consent was taken from the relatives of the patient. All preparation was done in aseptic

measures. For the Ultrasound group; linear probe was placed over the radial side of the wrist along Horizontal axis (out of plane) to locate radial artery and puncture the skin and artery with needle until artifact was seen puncturing the artery, then probe was placed along long axis (in-plane) to visualize the artery and guide the A-line during passing in the lumen with care not to puncture the back wall. The catheter was inserted under direct visualization as an artifact into the vessel lumen. If arterial blood was visible in the catheter lumen the attempt was deemed successful and catheter was secured at the place, otherwise another attempt was made to a total of 3 attempts. Figure-1 shows the different stages of ultrasound guided catheterization. For the palpatory group, index and middle finger were used to locate radial artery and after ascertaining its location, catheter was inserted, and next steps were same as the other group.

Figure-1: The first image shows radial artery being located with the probe placed out of the plane. The second image shows needle about to puncture the radial artery as viewed by placing probe out of the plane. The third image shows guide wire as marked by a yellow star, being introduced in the artery before catheter is passed over it

RESULTS

The results of the study showed that there were 23 patients of age 35 or less in group A where ultrasound was used for radial artery catheterization. While 40 patients were more than 35 years old. In group B, where Palpatory method was used, 26 patients were or age 35 years or less while 37 were older than 35 years. Mean age of group a was 38.1 ± 8.9 years while of group B was 36.8 ± 9.3 years. In group A, the mean number of attempts was 1.14 ± 0.35 and 1.29 ± 0.52 in group B ($p=0.08$). Table-I to III compare the results of both techniques in terms of successful catheterization in first attempt, haematoma formation and total time required. When total time required was stratified according to age, there was no statistical difference between the two groups in the patients with less than 35 years of age.



But the difference was statistically significant in the patients 35 or more years of age ($p = 0.003$). Similarly in both males and females, total time required in successful catheterization in group A was less and statistically significant than the palpatory method. Time required in group A was also better than B, when BMI of patients was less than 25 ($p = 0.009$). In overweight patients with BMI of 25 or more there was no statistical

difference ($p = 0.191$). When data was stratified according to age, gender and BMI no statistical difference of ultrasound for catheterization in first attempt was found in group A patients compared to group B. Similarly, age, gender and BMI had no effect on rate of haematoma formation among the two groups.

DISCUSSION

In the last decade, ultrasound technology has seen development not only as a diagnostic imaging modality but also as a therapeutic modality, where energy is deposited within the tissue inducing different biological effects. As it is emerging as a tool to guide radial artery catheterization, this study was designed to evaluate its role in a scientific manner to establish its role against the more prevalent palpatory method. It was both advantages and disadvantages over the palpatory method. Some advantages are for example improved planning, real time visualization, reduced time and improved rate of complication. On the other hand, some disadvantages are its availability, expense and training required. Radial artery catheterization was done with long axis/

longitudinal-in plane technique which is found to be slightly better as compared to short axis-out of plane technique.^{15,16}

In our study, only middle-aged patients were enrolled in the study, but more were older than 35 years old. This is consistent with the other studies as most patients comprised of middle-aged group or older as noninvasive techniques are used to measure blood pressure in pediatric age group usually.¹⁷ Most patients in the study group comprised of male patients, 66.6% and 61.9% in group A and B respectively. Other studies also were based on intervention mostly done on male patients, the reason being more patients admitted in ICU or HDU care after polytrauma.¹⁸

In this randomized control trial, successful radial artery catheterization was done in 85.7% patients of group A as compared to 74.6% in group B ($p = 0.118$) The ultrasound guided technique was found similarly better even in children as quoted in another study.¹⁹

Catheterization in First Attempt	Group		Total	Chi-Square P-Value
	A: Ultrasound Guided	B: Palpatory Method		
Yes	54 (85.7%)	47 (74.6%)	101 (80.2%)	$X^2=2.445a$ $P=.118$
No	9 (14.3%)	16 (25.4%)	25 (19.8%)	
Total	63 (100.0%)	63 (100.0%)	126 (100.0%)	
Mean	1.14	Mean 1.29	1.21	
Std. Deviation	.353	Std. Deviation .521	.449	
Minimum	1	Minimum 1	1	
Maximum	2	Maximum 3	3	

Table-I. Comparison between two groups according to catheterization in first attempt

Haematoma	Group		Total	Chi-Square P-Value
	A: Ultrasound Guided	B: Palpatory Method		
Yes	8 (12.7%)	14 (22.2%)	22 (17.5%)	$X^2=1.983$ $P=.159$
No	55 (87.3%)	49 (77.8%)	104 (82.5%)	
Total	63 (100.0%)	63 (100.0%)	126 (100.0%)	

Table-II. Rate of haematoma formation

Group Statistics					
	Group	N	Mean	Std. Deviation	T test P-Value
Total time in seconds	A: Ultrasound Guided	63	71.05	26.472	$t=-2.873$ $p=.005$
	B: Palpatory Method	63	95.56	62.331	

Table-III. Comparison of total time required between two groups

Most of the patients who were admitted fell into normal BMI range, in both groups. BMI is very critical in deciding the success of palpatory method as more subcutaneous fat in distal forearm hinders the palpation and thus catheterization of radial artery. BMI of group A was 24.01 ± 4.11 and was similar to group B, i.e. 24.00 ± 3.85 . High BMI not only itself causes difficulty but is associated with higher risk of sepsis as well.^{20,21} Due to this reason various modifications are needed in the catheter as well to prolong its life and decrease chances of surface colonization and arteritis.

We have also found that in group A, the mean number of attempts was 1.14 ± 0.35 as compared to 1.29 ± 0.52 in group 2 which was thus statistically not significant ($p=0.08$). There was a significant reduction in the mean number of attempts 1.17 ± 0.11 compared to 2.21 ± 0.13 ; in another study which compared the two methods. Here the difference was statistically significant. $P=0.03$.²² In our study 12.7% cases of group A developed haematoma as compared to 22.2% of group B ($p=0.15$) Although we did not rule out prior use of anticoagulation, but a study found no difference in rate of haematoma formation in patients with history of anticoagulation 5% as compared to 4.6% in patients without prior use who underwent radial artery catheterization.²³ Radial artery haematoma was reported in only 2.3% cases who underwent radial artery catheterization, although the study was questionnaire based.²⁴

Mean time required for group A patients was 71.0 ± 26.4 minutes while of group B was 96.5 ± 62.3 minutes, which was statistically significant, $p=0.31$. Successful catheterization was performed within 2 minutes in 57 cases as compared to 48 in group B. When stratification of data was done to compare the attempts among patients greater or lesser than 35 years, it revealed that comparable number of overall attempts were needed in young patients ($p=0.686$) whether ultrasound was used or palpatory method was used, than in older group ($p=0.063$). In other studies as well it was also found that increasing age resulted in increase in overall number of attempts in radial artery catheterization with palpatory method.²⁵ It increased from 1.42 ± 0.37 in patients younger

than 60 years as compared to 2.30 ± 0.83 in older group ($p<0.05$). Thus, ultrasound can greatly reduce the total number of attempts in older patients.²⁵

The results of our study clearly show advantage of ultrasound guided catheterization, yet the study had some limitations. We did not record infection at the site of catheterization, which can occur if there is breach in sterilization, chances of which are high in ultrasound guided technique. Vasospasm can occur and prevent backflow of blood in the catheter despite successful catheterization, which can be a confounding factor in case of palpatory method as placement cannot be confirmed with any other method. Moreover, we included patients with BMI < 35, hence we recommend further research to compare the two techniques in patients with high BMI.

CONCLUSION

Ultrasound guidance was found superior as it decreased the overall number of attempts, the total time required, increased the likelihood of successful catheterization in 1st attempt and less complication rate.

Copyright© 01 Aug, 2022.

REFERENCES

1. Min JJ, Tay CK, Gil NS, Lee JH, Kim S, Kim CS, et al. **Ultrasound-guided vs. palpation-guided techniques for radial arterial catheterisation in infants: A randomised controlled trial.** *Eur J Anaesthesiol.* 2019; 36(3):200–5.
2. Anand RK, Maitra S, Ray BR, Baidhya DK, Khanna P, Chowdhury SR, et al. **Comparison of ultrasound-guided versus conventional palpatory method of dorsalis pedis artery cannulation: A randomized controlled trial.** *Saudi J Anaesth.* 2019; 13:295–8.
3. La Colla L, Subramaniam K. **Out-of-plane versus in-plane radial artery cannulation in adult cardiac surgical patients: one size does not fit all.** Time to use a combined approach for radial artery cannulation? *J Cardiothorac Vasc Anesth.* 2021 Jun; 35(6):1898-9.
4. Cho SA, Jang YE, Ji SH, Kim EH, Lee JH, Kim HS, et al. **Ultrasound-guided arterial catheterization.** *Anesth Pain Med.* 2021; 16(2):119-32.

5. Ammar A, Ali L, Furqan A. **A randomized comparison of ultrasound guided versus blindly placed radial arterial catheters.** J Postgrad Med Inst 2017; 31(1): 8-11.
6. Nasreen A, Khuwaja AM, Akhtar P, Amjad N, Rao ZA. **A randomized comparison of ultrasound guided versus direct palpation method of radial artery cannulation techniques in adult patients undergoing open heart surgery.** Anaesth Pain & Intensive Care. 2016; 20(1): 38-42.
7. Amna, Mehboob S, Alam W, Gulraze A, Salim F. **Comparison of ultrasound guided radial artery cannulation with conventional palpation technique.** EC Anaesthesia 2015; 2(2): 85-9.
8. Shiver S, Blaivas M, Lyon M. **A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters.** Acad Emerg Med 2006; 13(12): 1275-9.
9. Ishii S, Shime N, Shibasaki M, Sawa T. **Ultrasound-guided radial artery catheterization in infants and small children.** Pediatr Crit Care Med 2013; 14(5): 471-3.
10. Wang A, Hendin A, Millington SJ, Koenig S, Eisen LA, Shiloh AL. **Better with ultrasound: Arterial line placement.** Chest 2020; 157: 574-9.
11. Tsao SL, Chen KY, Hsu WT, Lin SK, Chen CY. **A modified technique for ultrasound-guided cannulation of radial and brachial arteries in patients with circulation collapse.** Acta Anaesthesiol Taiwan 2008; 46(2): 91-4.
12. Gibbons RC, Zanaboni A, Saravitz SM, Costantino TG. **Ultrasound guidance versus landmark-guided palpation for radial arterial line placement by novice emergency medicine interns: A randomized controlled trial.** J Emerg Med. 2020; 59(6):911-7.
13. Arora NR, Maddali MM, Al-Sheheimi RAR, Al-Mughairi H, Panchatcharam SM. **Ultrasound-guided out-of-plane versus in-plane radial artery cannulation in adult cardiac surgical patients.** J Cardiothorac Vasc Anesth. 2021; 35(1):84-8.
14. Sokhal N, Khandelwal A, Sokhal S, Chaturvedi A. **Ultrasound-guided peripheral artery cannulation: A priority, not an option.** Indian J Anaesth. 2020; 64:167-8.
15. Liu C, Mao Z, Kang H, Hu X, Jiang S, Hu P et al. **Comparison between the long-axis/in-plane and short-axis/out-of-plane approaches for ultrasound-guided vascular catheterization: An updated meta-analysis and trial sequential analysis.** Ther Clin Risk Manag. 2018; 14: 331-40.
16. Kuo F, Park J, Chow K, Chen A, Walsworth MK. **Avoiding peripheral nerve injury in arterial interventions.** Diagn Interv Radiol. 2019; 25: 380-91.
17. Markovic S, Imhof A, Kunze M, Rottbauer W, Wöhrle J. **Standardized radial approach reduces access site complications: A prospective observational registry.** Coron Artery Dis. 2015; 26(1): 56-9.
18. 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: 178-83.
19. Zhang W, Li K, Xu H, Luo D, Ji C, Yang K, et al. **Efficacy of ultrasound-guided technique for radial artery catheterization in pediatric populations: A systematic review and meta-analysis of randomized controlled trials.** Crit Care. 2020; 24(1):197.
20. Yu MH, Chen MH, Han F, Li Q, Sun RH, Tu YX. **Prognostic value of the biomarkers serum amyloid A and nitric oxide in patients with sepsis.** Int Immunopharmacol 2018; 62: 287-92.
21. Riangiwat T, Limpruttidham N, Mumtaz T, Blankenship JC. **Coronary angiography in patients with arteria lusoria via right radial access: A case series and literature review.** Cardiovasc Revasc Med 2020; 21:417-21.
22. White L, Halpin A, Turner M, Wallace L. **Ultrasound-guided radial artery cannulation in adult and paediatric populations: A systematic review and meta-analysis.** Br J Anaesth 2016; 116(5): 610-7.
23. Gallego-Sánchez G, Gallardo-López A, Córdoba-Soriano JG, Gutiérrez-Díez A, Melehi D, Barrionuevo-Sánchez MI et al. **Safety of transradial diagnostic cardiac catheterization in patients under oral anticoagulant therapy.** J Cardiol 2017; 69(3): 561-4.
24. Mattea V, Salomon C, Menck N, Lauten P, Malur FM, Schade A et al. **Low rate of access site complications after transradial coronary catheterization: A prospective ultrasound study.** Int J Cardiol Heart Vasc. 2016; 14: 46-52.
25. Susanu S, Angelillis M, Giannini C, Binella R, Matteoni A, Bellucci R et al. **Radial access for percutaneous coronary procedure: Relationship between operator expertise and complications.** Clin Exp Emerg Med. 2018; 5(2): 95-9.

AUTHORSHIP AND CONTRIBUTION DECLARATION

No.	Author(s) Full Name	Contribution to the paper	Author(s) Signature
1	Sumayya Tariq	Conception, Analysis, Drafting, Analysis.	
2	Muhammad Omar Afzal	Conception, Case contribution, Drafting, Analysis.	