Original research article

A randomized trial comparing long-axis and modified short-axis USG-guided radial artery cannulation

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Abstract

Background: Many experts agree that the intra-arterial method is the most accurate way to assess blood pressure. A typical operation in the operating theatre and the intensive care unit is radial artery cannulation performed percutaneously.

Methods: Prospective, randomized study was performed between December 2021 to November 2022 at Department of Anesthesiology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar Hyderabad, India. In all, 100 patients participated in the trial, with 50 individuals assigned to each of two groups. Due to the fact that this is a single study, the number of participants was kept small.

Results: When it comes to continuous invasive blood pressure monitoring, arterial cannulation is considered to be the gold standard. The radial artery is the location that is selected most frequently for this purpose. It is usual practise to make use of ultrasound in this environment in order to raise the percentage of successful needle placements and lower the risk of problems.

Conclusion: Based on the results of our prospective, randomised, comparative study of USG-guided radial artery cannulation using the long axis technique versus the modified short axis technique, we found that the shorter ultrasonic location time and cannulation time for the modified SA-OOP technique were attributable to these changes

Keywords: randomized trial, long-axis, modified short-axis, USG-guided radial artery

Introduction

The measurement of IABP, or pressure within the arteries, is widely regarded as the "gold standard" for blood pressure monitoring. The radial artery is a typical site for percutaneous cannulation in operating rooms and intensive care units [1]. As a result, it is crucial to have a complete comprehension of the pertinent anatomy, procedural abilities, and probable challenges throughout the therapy. The first documented arterial cannulation took place in 1714, and it was performed by a priest named Stephen Hales. In 1949, Peterson et al. first described the use of tiny plastic catheters to monitor arterial blood pressure continuously during surgery. He used a metal needle to place them in his brachial artery[2-4]. Sweden's Sven Seldinger, a radiologist, was the first to successfully employ a catheter with a guide wire in 1953. This strategy is widely employed nowadays [5].

When it comes to arterial cannulation, the radial artery is the go-to because of its accessibility and high success rate. If the first attempt at cannulation is unsuccessful, a second one must be undertaken, which increases the likelihood of arterial spasm and complicates the process [6, 7]. Because of this, ultrasonic imaging is a straightforward, noninvasive technology that provides a more accurate diagnosis and localises the source of the problem. Improvements in resolution and tissue penetration for identification and desired action have been conceivable with the miniaturisation and mobility of current medical technologies [8, 9].

A waveform reading from the ascending aorta is required to provide an accurate image of arterial pressure. Comparison of the central aorta value with that of the peripheral arteries reveals a discrepancy. The systolic pressure in the dorsalispedis artery is greater than the systolic pressure in the radial artery, which is greater than the systolic pressure in the aorta [10, 12]. Aortic pressure is the weakest link in the chain. The resulting notch in the pulse waveform, known as a dicrotic notch, is the result of the loss of high-frequency components due to the distortion. In contrast to the rise in systolic pressure, the reduction in diastolic pressure indicates a decrease in cardiac output. The wave pattern is mirrored by the vessel walls, and the wave's amplitude and phase are altered as a result of the vessel's changing diameter and elasticity. This modification is also caused by the wave pattern being reflected off the vessel walls [13-15].

Ultrasound guiding has been proven to increase the rate of successful cannula insertion on the first try, reducing the risk of complications. This is especially true for radial artery cannulation. This study aims to compare the effectiveness of cannulating the radial artery using the conventional long-axis approach with the more recent short-axis adaptation.

Methods

Prospective, randomized study was performed between December 2021 to November 2022 at Department of Anesthesiology, Kamineni Academy of Medical Sciences and Research Centre, LB Nagar Hyderabad, India. In all, 100 patients participated in the trial, with 50 individuals assigned to each of two groups. Due to the fact that this is a single study, the number of participants was kept small.

Inclusion criteria

1. 20 to 80 years old
2. All consenting patients who were listed for surgical operations involving arterial cannulation for continuous blood pressure monitoring had an ASA I to III PS.

Exclusion criteria

1. Vascular disease of the periphery.
2. Haemorrhagic shock, second
3. Coagulation conditions
4. Obesity
5. A poor modified Allen's test result

Data collection procedures

Patients were enrolled in the study based on inclusion and exclusion criteria, with the help of an institutional Ethics Committee and with their signed agreement. Patients were randomly assigned by computer to one of two groups (group 1 or group 2). The patient's pulse oximeter, non-invasive blood pressure monitor, and electrocardiogram (ECG) were hooked up as soon as they entered the operating room, and their "baseline" readings (measurements made prior to the beginning of the procedure) were recorded. An 18G cannula was inserted into the vein of the arm to provide IV access. The next step was to put the patients under general anaesthesia. Each person was punctured on the left hand. The hand was positioned in dorsiflexion while the wrist was extended over a 10 cm roll and secured. The insertion location on the skin was sterilised, and 1ml of 2% lignocaine was used to provide local anaesthesia. The radial artery was located with the aid of an ultrasonic probe equipped with a disposable sterile cover operating at 18MHZ.

Modified short axis out of plane approach

For reference, we tied a 1-0 silk suture at the probe's middle, perpendicular to its long axis. The ultrasound image was then marked with a visible arrow pointing at the beating radial artery. It was determined how far the radial artery was buried beneath the surface of the skin and how wide its interior was. The artery cannula needle was inserted at a severe downward angle of 30 to 45 degrees at the spot where the suture line met the skin. Once the needle was inserted into the artery, the backflow of blood into the needle was visually confirmed. The needle was then angled down to 15 degrees and pushed proximally for a total of 2-3mm. The cannula was inserted into the radial artery, and the needle core was removed. Heparin saline was used to cleanse the arterial transducer extension and prepare it for use. After cannulating the artery, we immediately attached it to the extension tubing and watched the waveform.

Long axis in plane approach

Once the artery had been located using the ultrasonic probe's long axis, the inner diameter and distance from the skin to the artery had been measured, and the arterial cannula needle had been inserted at a sharp downward angle in the middle of the probe's short axis. Backflow of blood into the needle after insertion into an artery was visibly confirmed. At 15 degrees, the needle was pointed downward and pressed proximally for a distance of 2–3 mm. After the needle core was extracted, the cannula was placed into the radial artery. The arterial transducer extension was cleaned and sterilised with heparin saline before it was used. We watched the waveform right away after cannulating the artery by connecting it to the extension tubing.

Results

The data was analysed using IBM software. The information was analysed with SPSS 24.0. To summarise the information, we used frequency and percentage analyses, and for the continuous variables, we computed means and standard deviations. Whether or whether the bivariate samples of the two groups were significantly different was tested using the unpaired sample t-test. Statistical significance in the categorical data was determined using the Chi-Square test. All of these statistical techniques employ a.05. Significance level.

Comparison of the two groups' demographic profiles

Table 1: Age

Age	Group l	Group 2
<50years	40	38
>50 years	10	12
Total	50	50

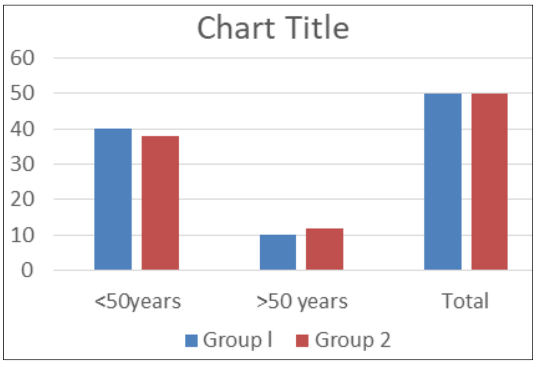

Fig 1: Age

Table 2: Sex

Gender	Group l	Group 2
Male	22	25
Female	18	15
Total	50	50

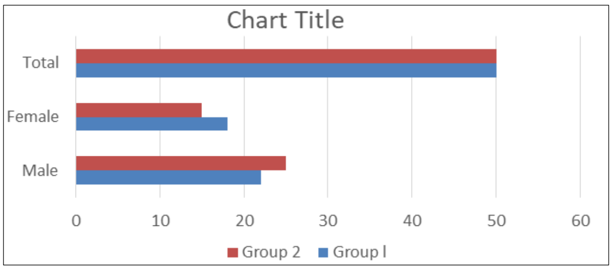

Fig 2: Sex

Baseline hemodynamic parameter comparison between the two groups

Table 3: Hemodynamic Parameters

Parameter	Group l (mean)	Group 2 (mean)	P value
Pulse	79.75	80.41	0.721
SBP	123.02	118.85	0.601
DBP	79.52	80.10	0.371

As a result, there is no statistically significant difference in the baseline measurements of the two groups' pulse rate, systolic blood pressure, and diastolic blood pressure.

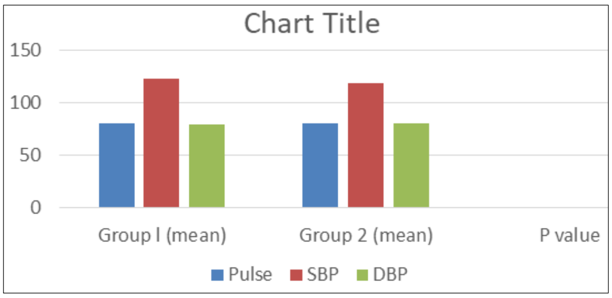

Fig 3: Hemodynamic Parameters

Radial artery inner diameter comparison

Table 4: Comparison of inner diameter

Parameter	Groups	Mean	SD	P value
Inner diameter of radial Artery	Group 1	3.124	±0.45	0.389
	Group 2	3.541	±0.31	

As a result, there is no statistically significant difference in the inner diameter of the radial artery between the two groups.

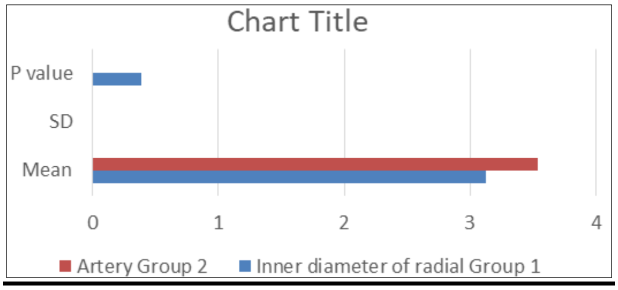

Fig 4: Comparison of inner diameter

Comparing the distance between the skin and the radial artery

Table 5: Comparison of depth from skin

Parameter	Modified SA-OOP Group mean (SD)	LA-IP approach Mean(SD)	P value	Mean difference
Depth from skin to radial artery (n cm)	0.7104±0.1725	0.7102±0.3014	0.9124	0.0042

Results regarding the difference in skin-to-artery depth between the modified SA-OOP and LA-IP groups were inconclusive. Normal values for ultrasonic positioning time in the modified SA-OOP method and the LA-IP method. Therefore, there is a statistically significant difference.

Comparison of the two groups' total attempts:

Table 6: Comparison of number of attempts

No of Attempts	Modified SA-OOP group n (%)	La-IP GROUP N(%)	P value
1	96.6	86.8	0.317
2	5.1	11.2	
3	0.0	2.0	

In general, the SA-OOP strategy has a greater first-attempt success rate and a lower second-attempt success rate than the LA-IP method. In this case, the P value of 0.294 is too high to be statistically significant (>0.05).

Comparison of the two groups' total number of redirections

Table 7: Comparison of number of redirections

Number of redirections	Modified SA- OOP approach n (%)	LA-IP approach n (%)	P value
0	1.9	74.8	0.001
1	38.8	24.9	
2	47.8	2.1	
3	11.4	0	

When compared to the LA-IP approach, the improved SA-OOP strategy dramatically reduces the number of redirections. Because of the low P value of 0.000, the result is statistically significant.

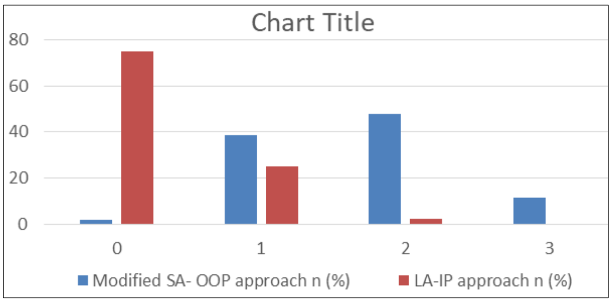

Fig 5: Comparison of number of redirections

Discussion

Although improvements have been made, arterial cannulation remains the gold standard for invasive blood pressure monitoring. The radial artery is the typical location for needle insertion. Ultrasound is commonly used in this setting because it increases the precision of needle placement and reduces the likelihood of complications. Ultrasound is sometimes referred to be a doctor's "third eye" due to its increased dependability and precision. With the improvement of ultrasonic probes and the rise of high-resolution ultrasonic equipment, the number of ultrasound-guided surgeries has increased dramatically. There are two primary approaches to ultrasonic needling, each with merits and downsides. The long axis in plane method and the short axis out of plane method are examples of these. It is considered a successful cannula insertion if the needle is able to puncture the blood vessel and the catheter is able to be advanced into the artery. Multiple factors influence both procedures. It is more difficult to puncture the radial artery precisely when its diameter is small. If the artery is especially deep, numerous attempts may be required. When the needle is just on the vessel wall or inside the vessel, it is not possible to advance the catheter. Ultrasound guiding has been shown to be superior to both conventional palpation and Doppler-assisted techniques in numerous scientific research. The effectiveness of different needling techniques has only been compared in a small number of studies [16-18].

In addition to no statistically significant differences in age and sex composition, pre-cannulation vital signs did not show any significant variation, either (pulse and blood pressure). There was no statistically significant difference in radial artery diameter or distance from the skin. They may affect both the ultrasonic locating time and the cannulation time [19].

The LA IP approach was compared to the SA-OOP method by Berk et al. According to their findings, the LA-IP approach had a greater rate of first success (76% vs. 51%). Our study contrasted the LA-IP strategy with a modified SA-OOP strategy. The modified SA-OOP technique obtained a 95.2% first-attempt success rate, while the LA-IP strategy only had an 87.9% success rate. Because of this, the number of individuals who need two or more attempts is minimisedutilising the SA-OOP approach in its modified form. Modified SA-OOP is so cutting edge that we must ensure its success or failure rate is thoroughly examined. For both sets of patients, cannula insertion proceeded smoothly. This occurred with previous investigations that contrasted the two approaches [20-22].

Kyung song et al. conducted research contrasting the short axis and long axis approaches employed by kids. When imaging the entire artery, the long-axis group had to wait significantly longer than the short-axis group because the transducer had to be rotated to get a long-axis image. Researchers Zhefengquan et al. observed that the average time required to detect an object utilising ultrasound may be greatly reduced by employing the short axis OOP modification. In our study, the SA-OOP group boasted a quicker Ultrasonic Location Time compared to the LA-IP group. The statistics did show some sort of trend, though. In order to successfully cannulate the radial artery using ultrasound guidance, the artery must be in the optimal viewing region. When comparing the LA-IP approach and the modified SA-OOP method, the latter is superior from a technological standpoint. The on-screen growing line is used to pinpoint the exact position of the artery for this purpose [23, 25].

The duration of the cannulation operation is another key outcome measure. The findings from Kyung Song et al. showed no statistically significant difference in the total time to cannulate between the two groups. As expected, the cannulation time for the short axis group was larger than that of the long axis group. In their study, Zhe Feng quan et al. discovered no statistically significant difference in the mean cannulation time between the two groups. Our results reveal that the modified SA-OOP group had a substantially lower cannulation time than the LA-IP group. The length of time spent cannulating is proportional to the number of times the process must be restarted. The enhanced SA-OOP approach has a higher rate of success on the first try than the LA-IP method. In a similar vein, the SA-OOP variant significantly cuts down on the amount of reroutes. Since the SA-OOP approach was modified, less time was spent on ultrasonic localization and cannulation. Because of the thickness of the ultrasound beam, overlapping images are created when the needle moves outside the vessels while remaining in section range of the ultrasound probe, leading the operator to incorrectly believe the needle is inside the vessel and requiring additional attempts and re-directions when using the LA-IP technique [25, 26].

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It is just as important to avoid complications as it is to accomplish a successful arterial cannulation. The posterior wall was punctured in 34% of patients in the LA-IP and SA-OOP groups, according to research by Moon et al. Although there was no discernible difference between the two groups, we did notice a trend showing that the modified S-OOP group had a higher rate of posterior wall puncture. By monitoring the complete needle's path instead of just its tip, the LA-IP method obviates the requirement for a posterior wall puncture [27].

There was no statistically significant difference between the short axis and long axis groups in terms of common complications such hematoma, vasospasm, and thrombosis. However, the modified short axis approach resulted in a somewhat decreased occurrence of hematomas. No significant difference in the incidence of complications such hematoma and vasospasm were seen across the groups. So, the SA-OOP approach has been tweaked to improve arterial puncture accuracy. This increases the proportion of first-time successes, minimizes the frequency of issues, and cuts down on redoes.

Conclusion

Our prospective, randomized, comparative investigation indicated that the shorter ultrasonic locating time and cannulation time for the modified SA-OOP approach were due to these adjustments. This was in comparison to USG-guided radial artery cannulation utilizing the long axis technique. The modified SA-OOP technique has a better rate of success on the first try and a lower rate of complications compared to the LA-IP technique.

Conflict of Interest: None

Funding Support: Nil

References

1. Allen EV.Thrombo-angiiisobliterans. Methods of diagnosis or chronic occlusive arterial lesions distal to the wrist, with illustrative cases. Am J Med Sciences.1929;178:237-44.
2. Wright IS. Vascular diseases in clinical practice. 2nd ed. Chicago: The Year Book Publishers Inc. 14. Johnson D, Ellis H (2005) Pectoral girdle and upper limb. In: Standring S, ed. Gray's;c1952.
3. Johnson D, Ellis H. Pectoral girdle and upper limb. In: Standring S, ed. Gray's anatomy. 799–942 New York: Elsevier Churchill Livingstone; c2005.
4. De Garis CF, Swartley WB. The axillary artery in white and negro stocks. Am J Anat.1928;41:353-397.
5. Johnson D, Ellis H. Pectoral girdle and upper limb. In: Standring S, ed. Gray's anatomy. 799–942 New York: Elsevier Churchill Livingstone; c2005.
6. Milzman D, Janchar T. Arterial Puncture and Cannulation. In: Roberts J, Hedges J. Clinical Procedures in Emergency Medicine. 4th ed. Philadelphia: W.B. Saunders;c2004. p. 384-399.
7. Milzman D, Janchar T. Arterial Puncture and Cannulation. In: Roberts J, Hedges J. Clinical Procedures in Emergency Medicine. 4th ed. Philadelphia: W.B. Saunders.2004;384-399:35.
8. Rijnders BJ, Van Wijngaerden E, Wilmer A, et al. Use of full sterile barrier precautions during insertion of arterial catheters: A randomized trial. Clin Infect Dis. 2003;36:743.
9. Sherertz RJ. Update on vascular catheter infections. CurrOpin Infect Dis. 2004;17:303.
10. O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter related infections. Centers for Disease Control and Prevention, MMWR Recomm Rep 2002;51(RR-10):1.
11. Goldstein RD, Gordon MJV. Volar proximal skin necrosis after radial artery cannulation. N Y State J Med. 1990;90:375.
12. Shiver S, Blaivas M, Lyon M. A prospective comparison of ultrasound-guided and blindly placed radial arterial catheters. AcadEmerg Med. 2006;13:1275-1279.
13. Schwemmer U, Arzet HA, Trautner H, et al. Ultrasound-guided arterial cannulation in infants improves success rate. Eur J Anaesthesiol. 2006;23:476-480.
14. Ganesh A, Kaye R, Cahill AM, et al. Evaluation of ultrasound-guided radial artery cannulation in children. PediatrCrit Care Med. 2009;10:45-48.
15. Dudeck O, Teichgraeber U, Podrabsky P, Haenninen EL, Soerensen R, Ricke J. A randomized trial assessing the value of ultrasound-guided puncture of the femoral artery for interventional investigations. Int J Cardiovasc Imaging. 2004;20:363-368.
16. Xiuyanli, Guizhen. Fang ultrasonic technology improves radial artery puncture and cannulation in intensive care unit shock patients med sci monitor. 2016;22:2409-2416.
17. Amna, SairaMehboob.Comparison of ultrasound guided radial artery cannulation with conventional palpation technique.EC anaesthesia.2015;2(2):85-89.
18. Nagabhushan S, Colella JJ, Wagner R. Use of Doppler ultrasound in performing percutaneous cannulation of the radial artery. Crit Care Med. 1976;4:327.
19. White ENR, Mitchell MM, Prakash O. Measurement of arterial pressure after cardiopulmonary

bypass with a long radial artery catheter. J CardiothoracAnesth. 1990;4:19.

20. DeryaBerk, YavuzGurkan. Usg guided radial artery cannulation: long axis versus short axis approaches. J clinmonitcomput. 2013;27:319-324.
21. Ganesh A, Kaye R, Cahill AM, et al. Evaluation of ultrasound-guided radial artery cannulation in children. PediatrCrit Care Med. 2009;10:45-48, 26.
22. McLeskey CH, Mims GR. Doppler-assisted radial artery cannulation. Anesthesiology. 1982;57:A25.
23. Sandhu NS. The use of ultrasound for axillary catheterization through pectoral muscles: a new anterior approach. AnesthAnalg. 2004;99:562-565.
24. Sandhu NS. Use of ultrasonography as a rescue technique for failed radial artery cannulation. J ClinAnesth. 2006;18:138-141.
25. Triffterer L, Marhofer P, Willschke H, et al. Ultrasound-guided cannulation of the great saphenous vein at the ankle in infants. Br J Anaesth. 2012;108:290-4.
26. Pirotte T, Veyckemans F. Ultrasound-guided subclavian vein cannulation in infants and children: a novel approach. Br J Anaesth. 2007;98:509-14.
27. Ueda K, et al. Ultrasound visual image-guided vs Doppler auditory-assisted radial artery cannulation in infants and small children by non-expert anaesthesiologists: a randomized prospective study. British Journal of Anaesthesia. 2013;110(2):281-6.
28. Jonathan R, et al. Ultrasound guided radial artery access by a Non-Ultrasound trained interventional cardiologist improved first-pass success rates and shortened time for successful radial artery cannulation. J Invasive Cardiol. 2013;25(12):676- 679.