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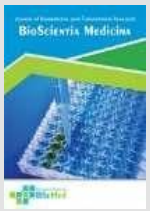

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Comparison of the Success Rate of Radial Arterial Cannulation with Palpation Techniques and Ultrasound Guidance in Patients Undergoing Major Surgery with General Anesthesia

Afriza Rizqi Zaini[1*], Fredi Heru Irwanto[2], Mayang Indah Lestari[2], Erial Bahar[3], SNA Ratna Sari Devi[4]

[1]Specialized Residency Training, Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Sriwijaya/Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

[2]Department of Anesthesiology and Intensive Therapy, Faculty of Medicine, Universitas Sriwijaya/Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

[3]Department of Anatomy, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

[4]Department of Radiology, Faculty of Medicine, Universitas Sriwijaya/Dr. Mohammad Hoesin General Hospital, Palembang, Indonesia

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***Corresponding author:**
Afriza Rizqi Zaini

E-mail address:
afrizarz@gmail.com

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A B S T R A C T

Background: Ultrasound-guided arterial cannulation has the potential to increase the total success rate and first attempt and reduce complications compared to conventional landmark palpation methods. This study aims to compare the success rate of radial artery cannula with palpation techniques and ultrasound guidance in patients undergoing major surgery under general anesthesia. **Methods:** This study is a randomized controlled trial singly. The inclusion criteria for this study were patients who underwent both emergency and elective surgery under general anesthesia, aged >18 years, with ASA I and II physical status. The study sample (60 people) was randomized by computer and divided into two groups (ultrasound guidance and palpation technique). The study will assess the success of the first insertion of the radial artery cannula in both groups. Data analysis was performed with SPSS 25 univariate and bivariate. **Results:** There is a significant relationship with the success of the first attempt at an ultrasound-guided cannula trial with a p-value of 0.045 with an odds ratio of 3.33 with a 95% confidence interval (0.998 – 11.139). **Conclusion:** Ultrasound-guided arterial cannulation has a better success rate and fewer complications than conventional palpation techniques.

1. Introduction

Arterial cannulation is an invasive monitoring technique that allows monitoring of blood pressure, assessment of fluid responsiveness, and collection of blood samples during the intraoperative period as well as in the intensive care unit. Several locations for arterial cannulation can be chosen, including the radial, posterior tibial, femoral, brachial, ulnar, and dorsalis pedis arteries. Each of these locations has certain advantages and disadvantages.[1-4] The most common location for an arterial catheter is the radial artery. The advantage of the radial artery is that it is shallow, accessible, and has a palm collateral blood supply from the ulnar artery.[5] Indications for arterial cannulation are invasive blood pressure monitoring

and accurate mean arterial pressure. Arterial cannulation may also be considered in patients who require frequent arterial blood samples or in certain patient conditions where noninvasive blood pressure monitoring is excluded, such as patients with extensive burns to the extremities, severe hypotension, multiple limb fractures, or extreme obesity. Absolute contraindications for arterial cannulation are absent pulse, Raynaud's syndrome, full-thickness burn at the proposed site of cannulation, and inadequate or interrupted circulation. Other contraindications include coagulopathy, arterial atherosclerosis, insufficient collateral perfusion, partial or full-thickness burns over the cannula insertion site, synthetic arterial or vascular grafts, or infection at the proposed cannula insertion site. Another common contraindication to arterial cannulation is anticoagulation, especially in those who have recently received thrombolytics for acute infarction.[6]

Installation of conventional arterial cannula palpation using the landmark technique by palpating the arterial pulse. The palpation technique requires an experienced doctor. The disadvantages of this procedure are that it requires several trials and results in patient discomfort, and causes the patient to experience bleeding and arterial spasm. [7] The use of ultrasound guidance is a well-validated adjunct to cannula insertion and is gaining popularity due to its reduced cannula failure rate.[8] The advantages of ultrasound guidance include real-time visualization, better pre-procedure planning, and reduction of catheter-related infections due to reduced trial and increased first-trial success.[9]

Major surgery is surgery of long duration, organ ischemia, blood loss of more than 1000 mL, high use of vasopressors, and postoperative metabolic stress response. Patients undergoing major surgery often suffer from significant comorbidities. Major surgery has 30-day morbidity of more than 30%, mortality of more than 2%, and generally requires intensive care. The expert panel cited intraoperative blood loss of more than 1000 mL, hemodynamic instability, duration of surgery, and organ ischemia as criteria for determining the prognosis for major surgery. During the administration of general anesthesia, the cardiovascular function may also be impaired.[10] This study aims to compare the success rate of radial artery cannula with palpation techniques and ultrasound guidance in patients undergoing major surgery under general anesthesia.

2. Methods

This study is an experimental study in the form of a single-blind randomized controlled clinical trial. The study was conducted at the Central Surgical Installation of Dr. Mohammad Hoesin General Hospital Palembang, Indonesia 1st May – 18th June 2022. A total of 60 research subjects grouped into two groups (groups 1 and 2) participated in this study. Sampling was done by randomization with computerized methods. Computer randomization was done by entering the sequences into the website https://www.random.org/lists/. The treatment group was divided into two groups, namely group 1 and group 2. Group 1 was the group where the radial artery cannula was placed with ultrasound guidance, while group 2 was the group where the radial artery cannula was placed using the palpation technique. The subject inclusion criteria were adult patients (≥ 18 years) who underwent major surgical procedures under general anesthesia at Dr. Mohammad Hoesin General Hospital Palembang, patients with ASA physical status I and II, and patients with elective or emergency surgery. The ultrasound used in this study was a SonoSite M-Turbo ultrasound with a linear (vascular) probe. The patient was positioned on the operating table, and general anesthesia was induced. Previously, the equipment for the radial artery cannula was prepared. The wrist to be attached is positioned flexed and propped up. Then performed, antiseptic action at the installation site using povidone-iodine. The installation of the radial artery cannula by palpation was carried out according to the clinical practice guidelines for arterial line installation. Installation of the radial artery cannula with ultrasound guidance was carried out according to

the Clinical Practice Guidelines for Arterial Line Installation. This study has been approved by the medical and health research ethics committee of Dr. Mohammad Hoesin General Hospital Palembang, No. 57/kepkrsmh/2022.

After the required data has been collected, the data is checked for completeness before being tabulated and processed. The data is said to be normally distributed if the p-value > 0.05 after being analyzed using the Shapiro-Wilk test. The data on the basic characteristics of the research subjects were analyzed using univariate to describe the population. Descriptive analysis in the form of numerical data is presented in the form of graphic tables and narratives. Numerical data are presented in the form of mean ± standard deviation if normally distributed and analyzed using the Independent T-Test. If not normally distributed, it is presented in the form of the median (minimum-maximum) and analyzed using the Mann-Whitney Test. The relationship between the two intervention groups with categorical variables (gender, ASA physical status, type of surgery, first trial success, and complications) was analyzed using Chi-Square or Fisher's Exact test. The differences between the two intervention groups with numerical variables (Age, BMI, duration, and number of trials) were analyzed using the Independent T-test.

3. Results

Table 1 shows general characteristics, including gender, age, body mass index, ASA physical status, and type of surgery. The majority of research subjects were male than female. After analyzing the Chi-Square test, it was found that there was no significant relationship (p = 0.602) between gender and the use of ultrasound guidance and palpation techniques. The age of the patients in this study was adults, with a mean (43.87 $\pm$ 12.96) in the ultrasound-guided group and (43.07 $\pm$ 15.99) in the palpation technique. There was no significant age difference between the two groups of patients (p = 0.832). The average body mass index of patients in this study was in the normoweight group, and there was no difference between the two treatment groups (p = 0.307). There was no significant relationship between ASA physical status and the treatment group, but descriptively, the ASA II group was higher than the ASA I group (p = 0.791). The type of surgery that uses the most arterial cannula is digestive surgery, obstetrics and gynecology (obsgyn), and neurosurgery. There was no difference in the type of surgery between the two treatment groups.

Table 1. Characteristics of research subjects.

Variables	Group		p
	Ultrasound guidance techniques	Palpation technique	
Gender, n (%)**			
Male	16 (47.1%)	18 (52.9%)	0.602
Female	14 (53.8%)	12 (46.2%)	
Age (years), mean ± SD*	43.87 $\pm$ 12.96	43.07 $\pm$ 15.99	0.832
Body Mass Index, median (min-max)*	21.15 (18.00 – 28 .63)	22.30 (15.97 - 24.39)	0.307
ASA, n (%)**			
I	12 (52.2%)	11 (47.8%)	0.791
II	18 (48.6%)	19 (51 ,4%)	
Types of surgery			
Neurosurgery	9 (56.3%)	7 (43.8%)	0.300
Obsgyn	4 (28.6%)	10 (71.4%)	
Digestive	6 (46.2%)	7 (53.8%)	
ENT	6 (75%)	2 (25%)	
Orthopedic	2 (50%)	2 (50%)	
Oncology	1 (33, 3%)	2 (66.7%)	
Thorax	0 (0%)	2 (100%)	

Data normally distributed: mean ± standard deviation
Data not normally distributed: median (minimum-maximum)
*Independent T-test/Mann-Whitney
**Chi-Square test

Table 2 shows the relationship between palpation technique and ultrasound guidance on the success of the first trial. Test analysis Chi-Square resulted in a p-value of 0.045 with an odd ratio of 3.33 and a 95% confidence interval (0.998 – 11.139). From the results of these tests, it can be concluded that the placement of an arterial cannula with ultrasound guidance significantly increases the first success rate in the installation of a radial artery cannula.

Table 2. Relationship of the success of the first trial.

Variables	The success of the first trial		P	OR (95% CI)
	Success	Unsuccessful		
Ultrasound guidance	25 (83.3%)	5 (16.7%)	0.045	3.333 (0.998 –11.139)
Palpation	18 (60%)	12 (40%)		

*Chi-Square test

In this study, a comparative analysis of the duration of insertion in the group that succeeded in the first insertion between the palpation technique and ultrasound guidance was performed. The duration of installation on the palpation technique was 75.29 $\pm$ 8.64 seconds, and the duration of installation on the ultrasound-guided technique was 155.09 $\pm$ 23.98 seconds. Table 3 shows a comparison of the duration of insertion on palpation and ultrasound guidance techniques. The results of the Independent T-test obtained a p-value of 0.006. From the test results, it can be concluded that the duration of insertion of arterial cannula using palpation technique is lower than using ultrasound guidance, with a significant difference between the two.

Table 3. Comparison of installation duration.

Variables	Installation duration (Second)	p
Palpation	75.29 $\pm$ 8.64	0.006
Ultrasound guidance	155.09 $\pm$ 23.98	

*Independent T-test

Table 4. A number of insertion trials.

Variable	Number of Trials	p
Palpation	1.76 $\pm$ 0.81	0.002
Ultrasound guidance	1.23 $\pm$ 0.56	

*Independent T-test

Table 4 shows the number of trials performed by operators in performing arterial cannulation using palpation techniques and ultrasound guidance. Analysis using an independent T-test showed that the difference in the number of trials between the group using the palpation technique and the group using ultrasound guidance was significant, with a p-value of 0.002.

Table 5. Installation complications.

Variable	Complications		P
	Palpation	Ultrasound guidance	
No	22 (73.3%)	26 (86.7%)	0.197
Hematoma	8 (26.7%)	4 (13.3%)	
Infection	0	0	
Neuro trauma	0	0	
Vasospasm	0	0	

*Chi-Square test

Table 5 shows complications of palpation technique and ultrasound guidance. The results of the Chi-Square test showed that in the installation of an arterial cannula, there was no significant difference in complications between those using the palpation technique and those using ultrasound guidance.

4. Discussion

The results of this study are in line with a systematic review that reviewed 6 randomized controlled trials with levels of evidence 1 to 2 with an adult study sample of at least 36 subjects and at most 749 subjects. The study showed a significant increase in the first-trial success of 14-37% and an overall success rate of 95% with ultrasound-guided arterial cannulation.[11-14] Another study also stated that the superiority of using ultrasound guidance was due to the fact that ultrasound was able to show the relative position of the needle along with the surrounding structures, namely blood vessels, especially the target arteries. This capability also provides an advantage in cases of obese and hypotensive patients and reduces the detrimental impact of anatomical variations on individual patients.[15] Ultrasound guidance provides superior visualization of radial artery structures. The operator can clearly see the projected movement of the needle tip dynamically and in real-time. This makes it easy for the operator to align the needle direction and speed with the visualization of the ultrasound screen. The successful installation of the radial artery cannula requires two successive steps. The first is to successfully pierce the radial artery, and the second is to insert (slide) the catheter into the lumen of the radial artery. The main cause of failure of the radial artery cannula with palpation technique is the most common in the second process, namely when the catheter is sliding into the lumen of the radial artery. This can be caused by the position of the radial artery puncture that is not optimal by the needle tip, anatomical variations in the radial artery, and vasospasm during the puncture.[16-18]

The palpation technique is quite good in identifying and confirming puncture of the radial artery by the cannula needle. The success of the puncture can be seen from the backflow of blood seen in the catheter needle tube. However, the palpation technique does not effectively assist the sliding of the catheter into the lumen properly. This is in contrast to ultrasound guidance which provides visualization advantages.[19] The position of the needle tip and the condition of the radial artery can be known precisely and in real-time before sliding so that the success of sliding the catheter into the arterial lumen is higher. But technically, operator experience also plays a role in the success rate, and experienced operators have a higher success rate than less experienced operators.[19]

5. Conclusion

Ultrasound-guided arterial cannulation has a better success rate and fewer complications than conventional palpation techniques.

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