ORIGINAL ARTICLE

Comparing the Efficacy and Success Rate of Radial Artery Approach under Ultrasound Guidance and Palpation Technique for Coronary Intervention at Central Chest Institute of Thailand

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Background: Previous studies of ultrasound guidance for transradial artery access during coronary angiography or interventional procedures demonstrate improving success rate, number of attempts, and short-time access in radial artery cannulation.

Objective: To compare the benefit of ultrasound guidance radial artery access during coronary angiography (CAG) or percutaneous coronary intervention (PCI) with palpation technique in experienced and inexperienced operators.

Materials and Methods: A randomized prospective study was performed between October 2021 and April 2022. One hundred sixty-four patients were randomized into three groups. The first group, group I (55 cases), underwent radial artery puncture with ultrasound guidance by an experienced interventionist. The second group, group II (56 cases), underwent radial artery puncture using the palpation technique by another experienced interventionist. The third group, group III (53 cases), was also assigned to radial artery puncture with the palpation technique, however, performed by three interventional cardiology fellows.

Results: The success rate of radial cannulation was 55 (100%) in group I, 52 (92.9%) in group II, and 48 (90.6%) in group III ($p=0.060$). First-attempt success rates in the three groups were 83.6%, 75%, and 69.8%, respectively ($p=0.233$). The median number of attempts was not significantly different ($p=0.208$). Time to access the radial artery in group I was reduced significantly compared to the palpation technique in group II and group III ($p<0.001$). There were no significant differences in complications such as difficult access, access site crossover, radial spasm, and hematoma/bleeding complication ($p=0.135$, 0.367, 0.132, and 0.700, respectively).

Conclusion: In experienced operators, an ultrasound-guided technique has been shown to have beneficial advantages in reducing the time to access radial artery cannulation compared to experienced and inexperienced operators using the palpation technique.

Keywords: Transradial catheterization; Ultrasound guide

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Cannulating the radial artery can be one of the most challenging aspects of the radial artery approach during coronary diagnostic and interventional procedures. The smaller caliber of the radial artery relative to the femoral or brachial arteries leads to a more technical difficulty in successful radial catheterization. The radial artery is small at 2.4 to 2.6 mm in diameter[1]. Because of this, it leads to increases in the number of failed attempts causing patient discomfort, radial artery spasms, and hematoma[2,3].

Ultrasound guide to access vascular cannulation has become more popular over the last ten years. Studies showed that ultrasound-guided radial artery puncture can increase safety, efficacy, and is faster than direct palpation[4-7]. Regarding coronary angiography, previous studies suggested improving the success rate and reducing the incidence of hematoma by ultrasound-guided radial artery cannulation[8,9].

In Thailand, the transradial artery approach in the coronary interventional procedure has become increasingly popular because of the advantages in lowering the incidence of bleeding risk and vascular

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complications, patient discomfort, earlier ambulation, shorter hospital stay, lower cost[10,11], and mortality. Those are the benefits according to the 2017 ESC guidelines for the management of acute myocardial infarction in patients that present with ST-T segment elevation as class I, level of evidence A[12]. However, the proportion of transradial catheterization during percutaneous coronary procedures performed at the Central Chest Institute of Thailand (CCIT) was still low, at approximately 19% to 22% in the last two years. To study the add-on benefits of ultrasound guides in accessing radial arteries during coronary interventional procedures, the present study aimed to compare the success rate in radial artery access for coronary intervention between ultrasound guidance and palpation techniques at the authors' institute.

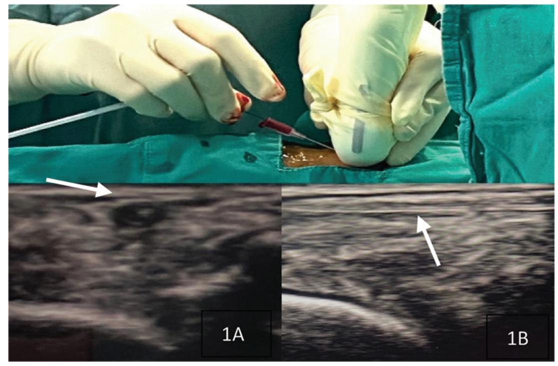

Figure 1. Ultrasound guidance of radial artery identify by short axis out-of- plane needle (1A) and long axis approach (1B).

Materials and Methods

The present study was a prospective randomized, single-centered study conducted at the CCIT, a tertiary care hospital with 330 in-hospital beds specializing in cardiopulmonary disease. Written informed consent was obtained from each patient before performing coronary angiography, fractional flow reserve (FFR), PCI procedures, and recruitment to the study. The Human Research Ethics Committee of the Central Chest Institute, Department of Medical Services, Ministry of Public Health of Thailand approved the present study protocol (COA 047/2564) and was registered with the Thai Clinical Trials Registry (TCTR 20220217007). The present study was conducted in compliance with the ethical standards of the responsible institution on human subjects as well as with the Helsinki Declaration.

After Ethical Committee approval, a randomized prospective study was performed between October 2021 and April 2022. One hundred sixty-four consecutive patients were recruited for the current study. Generated block randomization and divided into three groups of one-to-one-to-one according to the website Sealedenvelope.com were done. In the first group (group I), the operator had five years of experience in transradial access coronary angiography, with at least 100 cases per year and at least 20 cases of ultrasound guidance and were assigned to using an ultrasound guide for puncturing the radial artery. In the second group (group II), the operator also had five years of experience in transradial access coronary angiography, with at least 100 cases per year, and were assigned to using the palpation technique. In the third group (group III, which comprise of three interventional cardiology fellows), each operator experienced at least 20 transradial access coronary angiography cases and were assigned to the palpation technique[13]. The inclusion criteria were all the patients electively scheduled for CAG/PCI with clinically indicated. The exclusion criteria were emergency CAG/PCI, cardiogenic shock, peripheral arterial disease, post-CABG, and the patients with negative Allen's test or Modified-Allen's test result type D. An ultrasound transducer (Philips Lumify L12-4 Transducer, linear array transducer high frequency) was applied for real-time ultrasound guidance technique (Figure 1), identifying the radial artery with short axis, out-of-plane needle puncture (Figure 1A), and long axis (Figure 1B)[14]. The radial artery was measured at the inner diameter (Figure 2) and the distance from skin to the anterior wall of the radial artery at an anatomical landmark two centimeters proximal to the styloid process of radius (Figure 2A)[15]. The radial diameters were measured on two perpendicular axes, at the "9 o'clock to 3 o'clock" and the "6 o'clock to 12 o'clock" position. The average of the two diameters was then reported as the patient's radial artery diameter (Figure 2B).

The procedure was performed under the sterile technique by using local anesthesia. Radial artery access was obtained using a 20-gauge Jelco IV catheter (Smiths Medical, USA) and 5 or 6 Fr hydrophilic sheaths (Terumo). In the ultrasound guidance technique, an ultrasound transducer was applied, as demonstrated in Figure 1. The needle was inserted at the center of the transducer in a real-time fashion. In contrast, the palpation technique was performed by palpating the radial artery pulse, and the double wall puncturing technique was used. All patients received at least 100 ug of intraarterial nitroglycerin to prevent radial artery spasm, followed

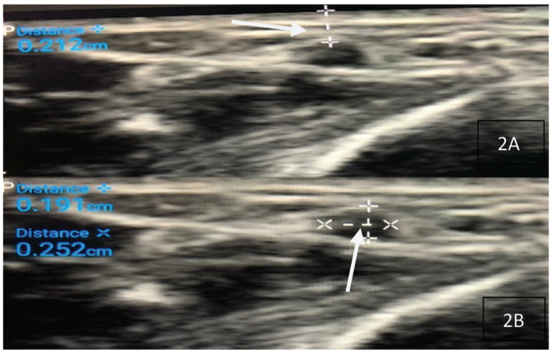

Figure 2. Measuring the distance from the skin to the anterior wall of the radial artery (2A) and the inner diameter of the radial artery on two perpendicular axes, at the "9 o'clock to 3 o'clock" and the "6 o'clock to 12 o'clock" position (2B).

by 3,000 to 5,000 U of intraarterial heparin for coronary angiogram or 70 to 100 U/kg of intraarterial heparin for percutaneous coronary intervention by transradial approach. If the ultrasound guidance and palpation technique were found to be difficult in radial artery access, the procedure was changed to the transfemoral approach instead.

Study endpoint

The primary endpoint included the success rate of cannulation of the radial artery, the first attempt success rate, the total number of attempts required for successful cannulation, and the time to establish access. The success rate was defined as total successful radial artery cannulation in five attempts or fewer. The first attempt success rate was determined as successful cannulation of the radial artery at the first attempt. The total number of attempts was defined as the number of attempts to complete successful cannulation[16]. The time to establish access was measured from the point of the first application of the operator's fingers or ultrasound probe to guide access to successful sheath insertion to the radial artery[8]. The secondary endpoint included the complications of the procedure, hematoma/bleeding, access site crossover, radial artery spasm, and difficult access. Hematoma/bleeding was defined according to the EASY classification of hematoma after transradial/ulnar PCI[17]. Access site crossover was defined as the change of position catheterization from radial artery access to femoral artery access. Spasm was described and identified by the operator as any significant resistance or patient felt pain with catheterization manipulation. Difficult access was defined as the number of punctures more than five times or the time to access cannulation was more than five minutes[8].

Statistical analysis

Data were respectively described using the mean (± standard deviation) for normally distributed variables or median (25th and 75th percentiles) for non-normally distributed. Data were also reported as frequency (percentage) for categorical data. The one-way ANOVA (Bonferroni multiple comparisons) and Kruskal-Wallis H test were used to compare continuous variables. In contrast, Chi-square and Fisher's exact test were performed for categorical variables among group I, group II, and group III. For all tests performed, a two-tailed p-value less than 0.05 was considered to be statistically significant. PASW Statistics, version 18.0 (SPSS Inc., Chicago, IL, USA) was used to perform all statistical analyses.

Results

During the study period, one hundred sixty-four patients underwent transradial catheterization. Baseline patient characteristics are summarized in Table 1. The mean age of patients was 62.8±10 years. Sixty-two percent of patients were male, and the mean body mass index (BMI) was 24.3±4.1 kg/m^2. There were no statistical differences in gender, age, or BMI among patient groups. The mean left ventricular ejection fraction was 54.0±16.3%. The medical histories of dyslipidemia, hypertension, diabetes mellitus type II, chronic kidney disease, and cerebrovascular disease were similar within the three groups. However, there were statistically significant differences in the clinical presentation of chronic coronary syndrome, previous PCI, and previous radial access in at least a pair of groups from the entire three groups (Table 1).

The patients' procedural characteristics are listed in Table 2. Baseline mean heart rate, mean systolic blood pressure, and mean diastolic blood pressure was 72.6±14.7 bpm, 127.9±19.0 mmHg, and 74.6±11.2 mmHg, respectively. The most accessible site was the right radial artery, and 6 Fr sheaths were used mainly in patients. There was a statistically significant difference in baseline heart rate. In the present study, the mean inner diameter of the radial artery measuring by ultrasound was 2.9±0.5 mm. There was no significant difference in mean inner radial diameter among the operator groups. There were no significant differences in blood pressure, puncture site, pain intensity when puncturing, nitroglycerine administration, and sheath diameter (Table 2). Most of the procedures were CAG and FFR. There was

Table 1. Baseline characteristics of patients between the operator groups

Characteristics	Total	Group I: Ultrasound-guided (n=55)	Group II: Palpation technique (n=56)	Group III: Palpation technique (n=53)	p-value
Sex; n (%)					0.628
Male	102 (62.2)	37 (67.3)	33 (58.9)	32 (60.4)	
Female	62 (37.8)	18 (32.7)	23 (41.1)	21 (39.6)	
Age (years); mean±SD	62.81±10.96	61.64±11.29	62.18±11.75	64.68±9.61	0.309
Body weight (kg); mean±SD	64.22±13.57	66.87±12.73	62.12±13.89	63.67±13.88	0.172
Height (m); mean±SD	1.62±0.09	1.63±0.08	1.62±0.09	1.62±0.08	0.753
BMI (kg/m^2); mean±SD	24.30±4.17	25.16±3.67	23.69±4.22	24.06±4.53	0.158
Clinical presentation; n (%)					
Chronic coronary syndrome	51 (31.1)	24 (43.6)	16 (28.6)	11 (20.8)	0.033
Acute coronary syndrome	46 (28.0)	11 (20.0)	15 (26.8)	20 (37.7)	0.118
STEMI post fibrinolytic	4 (2.4)	2 (3.6)	1 (1.8)	1 (1.9)	0.845
Valvular heart disease (pre-op.)	46 (28.0)	11 (20.0)	16 (28.6)	19 (35.8)	0.190
CHF/cardiomyopathy	27 (16.5)	10 (18.2)	9 (16.1)	8 (15.1)	0.906
LVEF (%); mean±SD	54.06±16.36	54.13±15.81	56.14±15.25	51.77±14.96	0.334
Condition; n (%)					
Previous PCI	45 (27.4)	25 (45.5)	10 (17.9)	10 (18.9)	0.001
Previous radial access	28 (17.1)	17 (30.9)	8 (14.3)	3 (5.7)	0.002
Family history of CAD	62 (37.8)	20 (36.4)	19 (33.9)	23 (43.4)	0.574
Dyslipidemia	153 (93.3)	53 (96.4)	50 (89.3)	50 (94.3)	0.360
Cerebrovascular disease	15 (9.1)	2 (3.6)	7 (12.5)	6 (11.3)	0.199
Obesity, BMI >30 kg/m2	2 (1.2)	1 (1.8)	0 (0.0)	1 (1.9)	0.591
Current/recent smoking (<3 months)	34 (20.7)	14 (25.5)	12 (21.4)	8 (15.1)	0.409
Hypertension	140 (85.4)	50 (90.9)	45 (80.4)	45 (84.9)	0.288
DM type II	60 (36.6)	18 (32.7)	18 (32.1)	24 (45.3)	0.278
CKD (eGFR <60 ml/minute)	38 (23.2)	13 (23.6)	10 (17.9)	15 (28.3)	0.432

BMI=body mass index; STEMI=ST segment elevation myocardial infarction; CHF=congestive heart failure; LVEF=left ventricular ejection fraction; PCI=percutaneous coronary intervention; CAD=coronary artery disease; DM=diabetes mellitus; CKD=chronic kidney disease; eGFR=estimated glomerular filtration rate; SD=standard deviation

no significant difference in coronary intervention and medication among the patient groups (Table 2).

In the present study, 155 (94.5%) patients had successful cannulation. Group I showed more successful cannulation than group II and group III. Most patients had first-attempt success, and the median number of attempts was one. There was no significant difference between the success rate of cannulation, the first attempt to success, and the number of attempts between operator groups. Group I and II used diagnostic catheters less than group III significantly (p=0.004). The median time to radial access cannulation was 1.46 minutes. Group I showed less time to access than group II and group III significantly (p<0.001). There was no significant difference in fluoroscopic time, procedural time, difficult access, radial spasm, and hematoma/bleeding by operators, as shown in Table 3.

Three fourth of the patients received one time of attempt for successful cannulation. Only one fourth of patients had more than one, as shown in Figure 3.

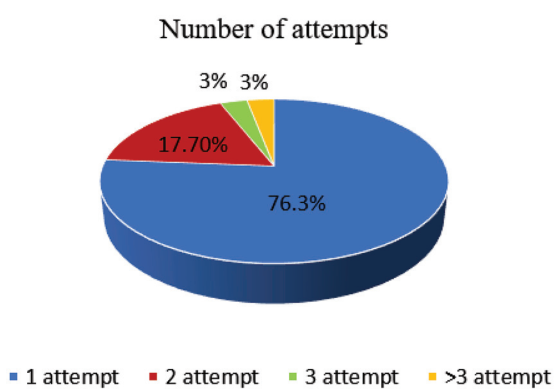

Figure 3. Number of attempts for successful cannulation in all patients (n=164).

The median time to access for radial artery cannulation of group I was less than that of group II and group III (p<0.001), as shown in Figure 4.

Table 2. Patient procedural characteristics between the operator groups

Factors	Total	Group I: Ultrasound-guided (n=55)	Group II: Palpation technique (n=56)	Group III: Palpation technique (n=53)	p-value
Baseline HR; n (%)					0.038
Mean±SD	72.63±14.76	69.29±14.66	72.27±14.68	76.49±14.33	
Sinus rhythm	135 (82.3)	44 (80.0)	43 (76.8)	48 (90.6)	0.145
AF	29 (17.7)	11 (20.0)	13 (23.2)	5 (9.4)	
Baseline systolic BP (mmHg); mean±SD	127.94±19.09	127.38±21.01	127.36±18.35	129.13±18.06	0.860
Baseline diastolic BP (mmHg); mean±SD	74.68±11.22	73.84±10.68	74.46±10.90	75.77±12.18	0.661
Puncture site; n (%)					
Right radial	159 (97.0)	52 (94.5)	55 (98.2)	52 (98.1)	0.534
Right femoral	6 (3.7)	2 (3.6)	2 (3.6)	2 (3.8)	1.000
Left radial	7 (4.3)	3 (5.5)	2 (3.6)	2 (3.8)	0.898
Pain intensity when puncture; n (%)					
No pain (0)	54 (32.9)	19 (34.5)	20 (35.7)	15 (28.3)	0.931
Mild pain (1-3)	58 (35.4)	21 (38.2)	19 (33.9)	18 (34.0)	
Moderate pain (4-6)	40 (24.4)	11 (20.0)	13 (23.2)	16 (30.2)	
Severe pain (7-10)	12 (7.3)	4 (7.3)	4 (7.1)	4 (7.5)	
Nitroglycerin IA (100 ug); n (%)					
1 dose	150 (91.5)	51 (92.7)	51 (91.1)	48 (90.6)	0.896
2 doses	5 (3.0)	2 (3.6)	2 (3.6)	1 (1.9)	
≥3 doses	9 (5.5)	2 (3.6)	3 (5.4)	4 (7.5)	
Systemic analgesic (fentanyl IV); n (%)	6 (3.7)	2 (3.6)	1 (1.8)	3 (5.7)	0.449
Sheath diameter; n (%)					
5F	23 (14.0)	9 (16.4)	7 (12.5)	7 (13.2)	0.824
6F	141 (86.0)	46 (83.6)	49 (87.5)	46 (86.8)	
Radial artery size (mm); mean±SD	2.9±0.5	2.8±0.5	3.0±0.5	2.8±0.4	0.152
Radial artery dept from skin (mm); mean±SD	2.4±0.9	2.5±0.9	2.3±0.9	2.4±0.7	0.628
Diagnosis CAG; n (%)					
Normal	7 (4.3)	2 (3.6)	4 (7.1)	1 (1.9)	0.506
Non-significant stenosis	36 (22.0)	7 (12.7)	14 (25.0)	15 (28.3)	0.117
TVD	71 (43.3)	26 (47.3)	22 (39.3)	23 (43.4)	0.697
DVD	23 (14.0)	10 (18.2)	6 (10.7)	7 (13.2)	0.515
SVD	27 (16.5)	10 (18.2)	10 (17.9)	7 (13.2)	0.739
PCI	44 (26.8)	20 (36.4)	15 (26.8)	9 (17.0)	0.076
FFR	9 (5.5)	3 (5.5)	4 (7.1)	2 (3.8)	0.910
Unfractionated heparin	161 (98.2)	54 (98.2)	55 (98.2)	52 (98.1)	1.000
Warfarin/NOAC	27 (16.5)	11 (20.0)	11 (19.6)	5 (9.4)	0.245

HR=heart rate; AF=atrial fibrillation; BP=blood pressure; IA=intraarterial; IV=intravenous; CAG=coronary angiography; TVD=triple vessels disease; DVD=double vessels disease; SVD=single vessel disease; PCI=percutaneous coronary intervention; FFR=fractional flow reserve; NOAC=non-vitamin K antagonist oral anticoagulant; SD=standard deviation

Table 4 demonstrates post-procedure complications after coronary intervention. Wound inflammation was found to be minimal. There were no significant differences between operators regarding post-procedural complications.

Discussion

In the present prospective randomized controlled study, it has been found that ultrasound-guided radial artery access technique did not improve the overall success rate of radial artery cannulation, first attempt success, number of attempts, and postprocedural complications over palpation technique of experienced operator. However, time to access was significantly decreased with ultrasound guidance compared with the palpation technique of both experienced and inexperienced operators.

The present research showed the benefit of the ultrasound in reducing the time to access the radial artery cannulation compared to the palpation

Table 3. Clinical outcomes of success and difficulties during radial artery cannulation between operators

Outcomes	Total	Group I: Ultrasound-guided (n=55)	Group II: Palpation technique (n=56)	Group III: Palpation technique (n=53)	p-value	p-value of multiple comparison
Successful of cannulation; n (%)	155 (94.5)	55 (100)	52 (92.9)	48 (90.6)	0.060	0.118[a], 0.05[b], 0.738[c]
First attempt to success; n (%)	125 (76.2)	46 (83.6)	42 (75.0)	37 (69.8)	0.233	0.262[a], 0.089[b], 0.544[c]
Number of attempts; median (P_{25}-P_{75})	1.0 (1.0 to 1.0)	1.0 (1.0 to 1.0)	1.0 (1.0 to 1.0)	1.0 (1.0 to 2.0)	0.208	0.298[a], 0.078[b], 0.453[c]
Number of diagnostic catheters; median (P_{25}-P_{75})	2.0 (1.0 to 2.0)	2.0 (1.0 to 2.0)	2.0 (1.0 to 2.0)	2.0 (2.0 to 3.0)	0.004	1.00[a], 0.009[b], 0.018[c]
Time to access (minutes); median (P_{25}-P_{75})	1.46 (1.00 to 2.46)	1.03 (0.49 to 1.50)	1.39 (1.03 to 2.20)	2.40 (1.50 to 3.54)	<0.001	0.011[a], <0.001[b,c]
Fluoroscopy time (minutes); median (P_{25}-P_{75})	8.35 (4.70 to 19.60)	10.20 (4.70 to 22.70)	6.27 (4.60 to 18.25)	8.80 (5.30 to 18.80)	0.339	0.163[a], 0.794[b], 0.274[c]
Procedural time (minutes); median (P_{25}-P_{75})	40.0 (20.0 to 65.0)	40.0 (20.0 to 75.0)	30.0 (20.0 to 60.0)	40.0 (30.0 to 65.0)	0.419	0.363[a], 0.777[b], 0.193[c]
Difficult access; n (%)	12 (7.3)	1 (1.8)	6 (10.7)	5 (9.4)	0.135	0.113[a], 0.110[b], 1.00[c]
Access site crossover; n (%)	13 (7.9)	2 (3.6)	6 (10.7)	5 (9.4)	0.367	0.271[a], 0.266[b], 1.00[c]
Anatomic abnormality; n (%)	4 (2.4)	1 (1.8)	2 (3.6)	1 (1.9)	1.00	1.00[a,b,c]
Tortuosity subclavian/brachiocephalic; n (%)	8 (4.9)	4 (7.3)	1 (1.8)	3 (5.7)	0.400	0.206[a], 1.00[b], 0.354[c]
Radial artery spasm; n (%)	10 (6.1)	1 (1.8)	6 (10.7)	3 (5.7)	0.132	0.113[a], 0.359[b], 0.490[c]
Accesses site complication; n (%)						
Hematoma/bleeding	24 (14.6)	7 (12.7)	10 (17.9)	7 (13.2)	0.700	0.453[a], 1.00[b], 0.504[c]
Grade 0	140 (85.4)	48 (87.3)	46 (82.1)	46 (86.8)	0.949	0.830[a], 1.00[b], 0.831[c]
Grade 1	18 (11.0)	5 (9.1)	8 (14.3)	5 (9.4)		
Grade 2	6 (3.7)	2 (3.6)	2 (3.6)	2 (3.8)		

[a] Group I vs. Group II, [b] Group I vs. Group III, and [c] Group II vs. Group III, for multiple comparison was used chi square test and Kruskal-Wallis analysis

Table 4. Post-procedure complications during 24 hours follow-up period between operators

Complications	Total n (%)	Group I: Ultrasound-guided (n=55); n (%)	Group II: Palpation technique (n=56); n (%)	Group III: Palpation technique (n=53); n (%)	p-value
Wound description					0.704
Normal	152 (92.7)	52 (94.5)	52 (92.9)	48 (90.6)	
Abnormal	12 (7.3)	3 (5.5)	4 (7.1)	5 (9.4)	
• Swelling	11 (6.7)	3 (5.5)	3 (5.3)	5 (9.4)	0.464
• Bleeding	1 (0.6)	0 (0.0)	1 (1.8)	0 (0.0)	1.00
Antibiotics used	8 (4.9)	3 (5.5)	2 (3.6)	3 (5.7)	0.820

technique. The time to access was defined from the point of the first application of the operator's fingers or ultrasound probe guide to access until successful sheath insertion[8]. These results suggest that "seeing" the small radial artery on ultrasound may be more accurate than "feeling" the artery due to limiting the 2-point discrimination of the fingertip palpation. Ultrasound may identify the location and patency of the artery suitable for vascular access, particularly in patients with difficulty with palpation alone or a weak pulse caused by a deep, small artery or hypotension.

The authors' finding is concordant with the previous trial of Camuglia et al. His single-center study found that routine ultrasound guidance to assist in transradial access did not significantly improve the parameters of successful vascular access among high-volume radial operators. This study compared experienced operators and interventional cardiology fellows[18]. In contrast, a multicenter study by Seto et al. (RAUST) found that ultrasound guidance reduced

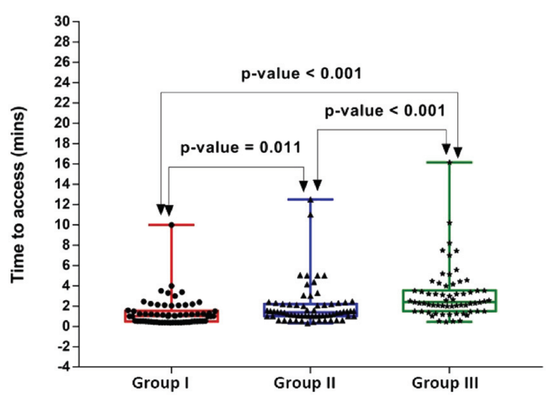

Figure 4. Time to access between operators.

the number of attempts, first attempts success rate, and time to access, with no significant difference in spasms, patient pain, or bleeding complications. The study was done by comparing experienced operators and interventional fellows[8]. Furthermore, a meta-analysis done by experienced interventionists from Bhattacharjee et al. found that ultrasound guidance may increase the first attempt success rate but not the overall cannulation success compared to palpation technique in the operating room, emergency department, and cardiac catheterization lab[19]. The most recent meta-analysis done by experienced operators from Moussa Pacha et al. showed that the ultrasound-guided approach for radial artery access has a higher first-attempt success and lower failure rate compared with palpation alone, with no significant differences in access site hematoma or time to a successful attempt[20].

The present study compared experienced with inexperienced operators for transradial catheterization. The experienced operator had more success in cannulation and used a smaller number of attempts than the inexperienced operator, even with non-statistical significance (Table 3). Time to access was shortest in the experienced operator with ultrasound guidance with statistical significance (Table 3, Figure 4). This technique can be used in everyday life. It may be applied in clinical emergency CAG or PCI to reduce time to assess radial artery cannulation or as a rescue technique after initial palpation attempts fail. From the present study results, ultrasound screening to measure the size of the radial artery or screen for anatomical variation may be an additional benefit to selecting sheath sizes or access sites to minimize radial artery spasms or procedural failure.

Limitation

From the present study design, the ultrasound-guided technique was not used after the failure of the palpation technique. The aim of the present study was not to compare the inexperienced operators with the palpation technique to the inexperienced operators with ultrasound guidance for radial artery cannulation. The current results needed adequate power for the clinical outcomes. Therefore, the benefit of ultrasound guidance was limited only to procedure success and efficiency. The operational cardiology staff or intervention fellows familiar with the ultrasound guidance technique will likely benefit from radial artery cannulation. Finally, the present study had a limited number of patients and was performed at a single center. Further study should be conducted with a larger sample size in multicenter hospitals.

Conclusion

In experience operators, the ultrasound-guided technique has been shown to have beneficial advantages in reducing the time to access radial artery cannulation compared to experienced and in-experienced operators using the palpation technique.

What is already known on this topic?

Ultrasound is a guidance tool for radial artery cannulation for coronary intervention procedures. The ultrasound can be used in everyday life or bailout situations in the cardiac catheterization lab.

What this study adds?

The experienced operators using the ultrasound-guided radial artery cannulation did not produce a better result than the palpation technique. However, this study results demonstrated that, by using ultrasound-guided puncture, the experienced operators could reduce the time to access radial artery cannulation compared to experienced or inexperienced operators using the palpation technique.

Conflicts of interest

The authors declare no conflicts of interest.

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