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Anatomical Snuffbox Versus Dorsum of the Hand for Optimal Access Site in Distal Radial Access: Insight From the KODRA Registry

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AUTHOR'S SUMMARY

The distal radial access (DRA) has two potential puncture sites: the anatomical snuffbox and the dorsum of the hand. However, the optimal site has not yet been determined. Based on the analysis of the KODRA registry, the anatomical snuffbox approach offers advantages in terms of puncture success and the completion of coronary procedures without access-site crossover, whereas access via the dorsum of the hand is associated with a lower incidence of prolonged hemostasis, although no difference in bleeding risk was observed. Understanding

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the safety and efficacy of these two access sites in DRA may help improve puncture-related outcomes in daily clinical practice.

ABSTRACT

Background and Objectives: Distal radial access (DRA) has been recognized as an alternative to conventional radial access, with potential puncture sites at the anatomical snuffbox and on the dorsum of the hand. However, the optimal puncture site remains unknown. This study aims to evaluate the efficacy and safety of DRA at these two sites.

Methods: This analysis was performed using the KODRA (Korean Prospective Registry for Evaluating the Safety and Efficacy of Distal Radial Approach) registry. The primary efficacy endpoint was defined as successful puncture and completion of the coronary procedure without access-site crossover, while the primary safety endpoint was the DRA-related bleeding.

Results: A total of 4,977 and 4,644 patients were included in efficacy and safety analyses, respectively. DRA via the anatomical snuffbox improved the primary efficacy endpoint (odds ratio [OR], 2.358; 95% confidence interval [CI], 1.800–3.090; p<0.001), but did not differ from the dorsum of the hand approach in the primary safety endpoint (OR, 1.305; 95% CI, 0.792–2.150; p=0.296). The anatomical snuffbox approach was also associated with higher puncture success rates (OR, 2.244; 95% CI, 1.672–3.010; p<0.001), but with an increased rate of prolonged hemostasis >180 minutes (OR, 15.002; 95% CI, 7.708–29.197; p<0.001).

Conclusions: Compared to the dorsum of the hand approach, DRA via the anatomical snuffbox demonstrated higher procedural efficacy, but was associated with prolonged hemostasis, without an increase in DRA-related bleeding. Further research is needed to determine the optimal site for DRA.

Keywords: Distal radial access; Radial artery; Coronary angiography; Percutaneous coronary intervention

INTRODUCTION

Distal radial access (DRA) has emerged as an alternative access route to conventional transradial access (TRA) for coronary procedures. Studies comparing DRA and TRA have demonstrated that DRA significantly reduces access-site complications, including radial artery occlusion (RAO) and bleeding events, while maintaining comparable efficacy in terms of successful puncture rate and outcomes of coronary procedures, even in complex percutaneous coronary interventions (PCIs).[1-6] As a result, DRA via the anatomical snuffbox or dorsum of the hand has become an alternative access route to further reduce the access-site complications in cardiovascular interventions.

There are two potential puncture sites in DRA: the first is the anatomical snuffbox, a triangular-shaped area bordered by the tendons of the extensor pollicis longus and brevis; the second is the dorsum of the hand, located more superficially in the first intermetacarpal space.[7] The puncture site is usually determined according to the operator's preference near the anatomical snuffbox, where the pulse is easily palpable or the artery is well visualized on ultrasound.

However, given the distinct course and anatomical relationships of the distal radial artery, the procedural efficacy and safety of DRA may vary between the anatomical snuffbox and the dorsum of the hand, especially during coronary procedures and hemostasis. Currently, there is a lack of comparative data on DRA between these two access sites for coronary procedures. Therefore, this study aimed to identify the optimal access site for DRA in terms of efficacy and safety, utilizing data from a large-scale, real-world registry

## METHODS

Ethical statement
The KODRA study was approved by the Institutional Review Board (IRB) of Busan Paik Hospital (IRB No. 2019-09-023) and other participating sites. It was conducted in accordance with the Declaration of Helsinki (2013), and all participants provided written informed consent.

Study population and design
The KODRA (Korean Prospective Registry for Evaluating the Safety and Efficacy of Distal Radial Approach; NCT04080700) trial was a prospective multicenter registry to examine the safety and feasibility of DRA for routine coronary procedure. Patients aged >20 years with a palpable distal radial artery and an indication for coronary angiography or PCI were considered eligible for enrollment in this registry. Exclusion criteria included a non-palpable distal radial artery, a positive modified Allen test, pregnancy, breastfeeding, and any condition deemed unsuitable by the investigator. A total of 5,712 consecutive patients undergoing coronary procedure were screened and 4,977 patients were finally enrolled in 14 participating hospitals in South Korea between September 2019 and September 2021. The design and results of the KODRA trial have been described in detail previously.[8] To compare the efficacy of DRA between the anatomical snuffbox and the dorsum of the hand approach, 4,977 patients from KODRA registry were included. After excluding patients with puncture failure and access-site crossover for coronary procedure, 4,644 patients who underwent DRA were included for safety analysis. The flow chart of this study is presented in **Figure 1**. Baseline characteristics, procedural findings, clinical outcomes, and puncture-related data including puncture location, time, success, and access-site complications were collected prospectively for all enrolled patients. To compare the two access sites in DRA, participants were divided into the anatomical snuffbox approach and the dorsum of the hand approach, regardless of whether the right or left distal radial artery was used for access.

Study procedures
The choice of right or left distal radial artery was left to the discretion of the operator. After identifying palpable pulse or distal radial artery on ultrasound around the anatomical snuffbox, the operator confirmed whether expected puncture sites were in the anatomical snuffbox or on the dorsum of the hand. Subcutaneous injection of 2% lidocaine was administered at the puncture site, and arterial puncture using a 20-gauge veinpuncture catheter needle or a 21-gauge open steel needle was performed. Once a pulsatile blood was obtained through the needle, a 0.021-inch sheath guidewire was advanced through the puncture needle. In case of difficulty in advancing a manufactured 0.021-inch sheath wire, additional 0.014-inch guidewires for PCI were used. The introducer sheath was deployed in the artery, and spasmolytics and unfractionated heparin was administered through the inserted sheath. After completion of the procedure, hemostasis was performed
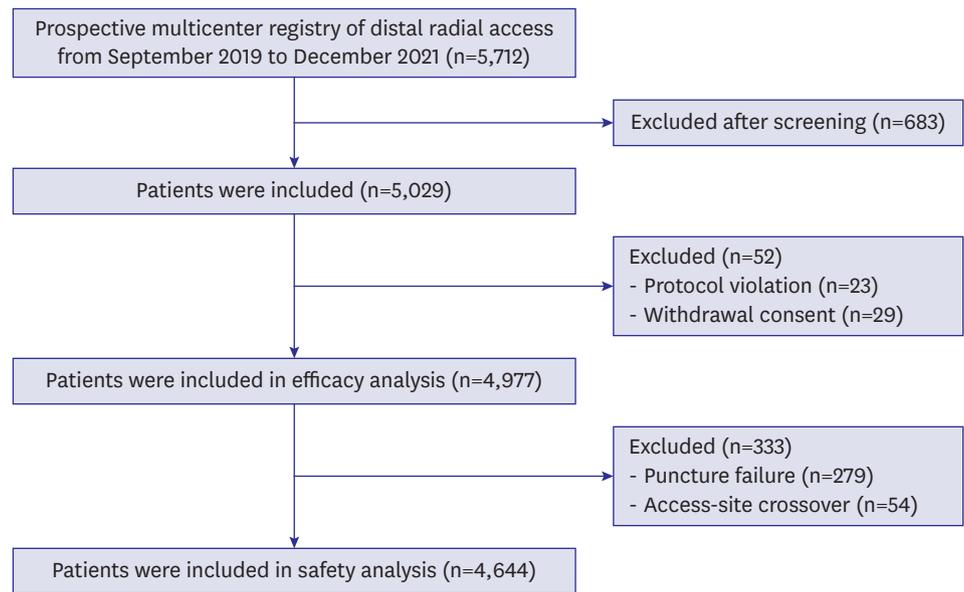
Figure 1. Flow chart of study population.

according to the protocol of each institution with gauze plug with adhesive tape fixation, elastic bandage wrapping, compression device, and manual compression.

Study endpoints and definitions

The primary efficacy endpoint of this trial was defined as successful puncture with completion of the coronary procedure without access-site crossover from the initial puncture site.

The primary safety endpoint was defined as DRA-related bleeding in patients who successfully underwent a coronary procedure without crossover. Secondary endpoints were defined as the puncture success for efficacy outcome, whereas secondary safety endpoint included prolonged hemostasis, defined as time to hemostasis exceeding 180 minutes of the median hemostasis time. Time to hemostasis was defined as the total duration from sheath removal to the achievement of complete hemostasis, without the need for any additional recompression due to overt bleeding, persistent oozing or an enlarging hematoma. Access-site complications included DRA-related bleeding, RAO or distal radial artery occlusion (DRAO), neuropathic symptoms, and any reported vascular complications such as perforation, dissection, pseudoaneurysm, and fistula. The access site for DRA was classified as follows: 1) Anatomical snuffbox approach was defined as a puncture in the anatomical snuffbox, located between tendons of the extensor pollicis longus and extensor pollicis brevis, 2) The dorsum of hand approach was defined as an access of the distal radial artery on superficial area between the anatomical snuffbox and the first intermetacarpal space (**Figure 2**). Puncture time was the duration from the initial contact of the puncture needle on the skin to advance the guidewire into the distal radial artery. Access time was measured as the total duration from subcutaneous lidocaine administration to placement of the introducer sheath. Pulse quality was classified into four categories—very good, good, weak, or absent—based on the operator's subjective assessment performed before arterial puncture. Bleeding events were assessed based on the Bleeding Academic Research Consortium (BARC) criteria, and hematoma was classified using the modified Early Discharge After Transradial Stenting of Coronary Arteries Study (EASY) criteria.[9)10)]
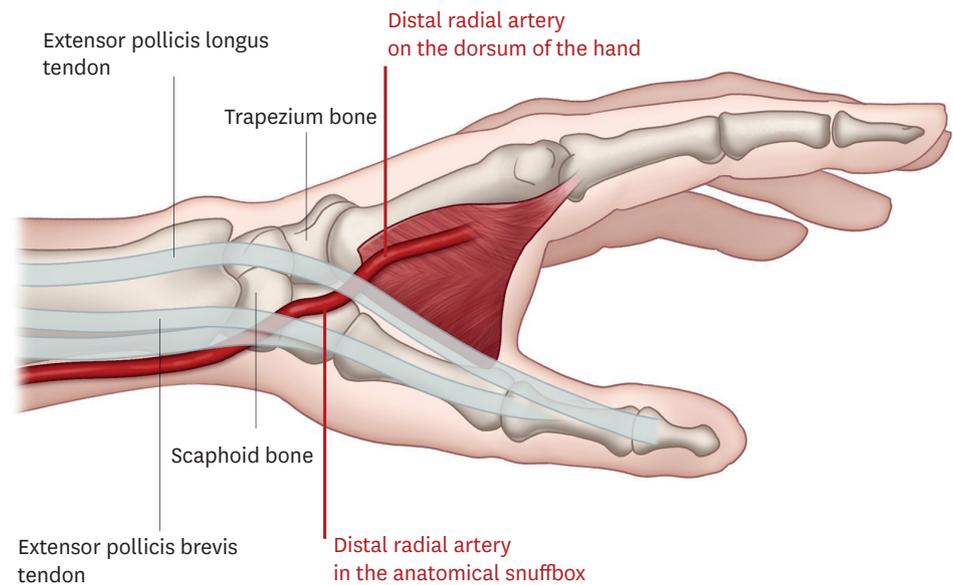
Figure 2. Two access sites in distal radial access.
The schematic illustration shows two potential access sites in distal radial access and relevant anatomic structures. The distal radial artery in the anatomical snuffbox located between tendons of the extensor pollicis longus and extensor pollicis brevis, with its floor formed by the scaphoid and trapezium bones. On the dorsum of the hand, the distal radial artery runs more superficially in the first intermetacarpal space, separated from the anatomical snuffbox by the extensor pollicis longus tendon.

Statistical analysis

Continuous variables with a normal distribution are presented as mean ± standard deviation, whereas those with a non-normal distribution are presented as median and interquartile range. Differences in continuous variables between the anatomical snuffbox approach and the dorsum of the hand approach were analysed using Student's t-test for normally distributed variables or the Mann–Whitney U-test for non-normally distributed variables. The Kolmogorov–Smirnov test was used to assess the normality of continuous variables. Categorical variables are expressed as frequencies and percentages, and were compared between the two groups using Fisher's exact test.

To evaluate the effects of different variables on efficacy and safety outcomes, multivariable logistic regression analysis was conducted to estimate both unadjusted and adjusted odds ratios (ORs) with corresponding 95% confidence intervals (CIs) for each endpoint. For the analysis, pulse quality was dichotomized into 'good' (comprising very good and good) and 'weak.' The multivariable model was adjusted for several factors: age, gender, distal radial pulse status, DRA experience, use of ultrasound, body mass index, type of puncture needle, use of anticoagulants or P2Y12 receptor antagonists, use of large sheath (≥6 French), and clinical presentation at the index procedure. It also accounted for coronary risk factors including diabetes mellitus, hypertension, dyslipidemia, chronic kidney disease, smoking, history of PCI, and acute myocardial infarction (AMI). Subgroup analyses were conducted based on clinically relevant variables potentially affecting the primary safety and efficacy endpoints, including age, sex, DRA experience, PCI, heparin use, sheath size, and hemostasis method. Tests for interaction were performed, and a p value for interaction <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software (version 25, IBM SPSS, Armonk, NY, USA).

RESULTS

Study population and characteristics

A total of 4,977 patients who underwent DRA were enrolled in this study. The mean age was 66.4±11.9 years. Of these, 3,363 (67.6%) were males. Baseline clinical and procedural characteristics are presented in **Tables 1** and **2**. Patients undergoing DRA via the anatomical snuffbox were older, had lower left ventricular ejection fractions, less likely to be current smokers, and higher rates of females, use of heparin, hypertension, dyslipidemia, history of myocardial infarction, and previous PCI. There was no significant difference in pulse status, use of oral anticoagulants, history of CKD, or initial clinical presentation as AMI (15.6% in the snuffbox approach vs. 12.8% in the dorsum of the hand approach; p=0.051) between the two groups. Operators with fewer than 100 cases of experience performed 29.8% of DRA via the anatomical snuffbox and 16.9% via the dorsum of the hand. Large sheaths (6 or 7 Fr) were used in 44.1% of the anatomical snuffbox approach and 35.7% of the dorsum of the hand approach in DRA.

Table 1. Baseline characteristics of study population

Variables	Anatomical snuffbox (n=4,190)	Dorsum of the hand (n=787)	p value
Age (years)	66.6±11.9	65.3±11.8	0.004
Male	2,796 (66.7)	567 (72.0)	0.003
Body mass index (kg/m²)	24.9±3.7	25.0±3.6	0.417
Risk factors			
Current smoker	892 (21.3)	203 (25.8)	0.005
Diabetes mellitus	1,552 (37.0)	279 (35.5)	0.396
Hypertension	2,694 (64.3)	472 (60.0)	0.021
Dyslipidemia	2,432 (58.0)	412 (52.4)	0.003
Chronic kidney disease	310 (7.4)	50 (6.4)	0.299
Atrial fibrillation	274 (6.5)	61 (7.8)	0.213
Past history			
Previous MI	459 (11.0)	124 (15.8)	<0.001
Previous PCI	952 (22.7)	246 (31.3)	<0.001
Previous CABG	24 (0.6)	5 (0.6)	0.833
Previous stroke	301 (7.2)	69 (8.8)	0.120
Indication for CAG			<0.001
Stable angina	1,102 (26.3)	203 (25.8)	
Unstable angina	940 (22.4)	166 (21.1)	
NSTEMI	456 (10.9)	71 (9.0)	
STEMI	196 (4.7)	30 (3.8)	
Variant angina	144 (3.4)	21 (2.7)	
Preoperative evaluation	121 (2.9)	8 (1.0)	
Follow-up CAG	257 (6.1)	129 (16.4)	
Heart failure	163 (3.9)	18 (2.3)	
Atypical chest pain	358 (8.5)	88 (11.2)	
Others	453 (10.8)	53 (6.7)	
Proportion of acute MI	652 (15.6)	101 (12.8)	0.05
Antithrombotic agents			
Aspirin	2,407 (57.4)	383 (48.7)	<0.001
Clopidogrel	1,822 (43.5)	263 (33.4)	<0.001
Ticagrelor	612 (14.6)	120 (15.2)	0.641
Prasugrel	19 (0.5)	12 (1.5)	0.002
Warfarin	19 (0.5)	6 (0.8)	0.261
DOAC	121 (2.9)	23 (2.9)	0.958
Use of heparin	4,070 (97.1)	530 (67.3)	<0.001

Values are presented as mean ± standard deviation or number (%).
CABG = coronary artery bypass graft; CAG = coronary angiography; DOAC = direct oral anticoagulant; eGFR = estimated glomerular filtration rate; HbA$_{1c}$ = hemoglobin A1c; HDL = high density lipoprotein; LDL = low density lipoprotein; LV = left ventricle; MI = myocardial infarction; NSTEMI = non–ST-segment elevation myocardial infarction; STMEI = ST-segment elevation myocardial infarction; PCI = percutaneous coronary intervention.

Table 2. Procedural characteristics

Variables	Anatomical snuffbox (n=4,190)	Dorsum of the hand (n=787)	p value
Experience of DRA			<0.001
<100 cases of experience	1,248 (29.8)	133 (16.9)	
100–499 cases of experience	1,020 (24.3)	213 (27.1)	
≥500 cases of experience	1,922 (45.9)	441 (56.0)	
Weak pulse	633 (15.1)	138 (17.5)	0.086
US-guided puncture	275 (6.6%)	45 (5.7%)	0.428
Puncture with open steel needle	1,535 (36.6%)	452 (57.4%)	<0.001
Spasm provocation test	623 (14.9)	103 (13.1)	0.206
Coronary procedure via DRA (n=4,644)	n=3,947	n=697	
Disease extent			0.044
Normal or minimal disease	1,616 (40.9)	259 (37.2)	
1-vessel disease	1,093 (27.7)	182 (26.1)	
2-vessel disease	724 (18.3)	153 (22)	
3-vessel disease	514 (13)	103 (14.8)	
PCI	1,397 (35.4)	209 (30.0)	0.061
Complex PCI			
Multi vessel	356 (9.0)	52 (7.5)	0.204
Left main	35 (0.9)	7 (1.0)	0.932
CTO	73 (1.8)	10 (1.4)	0.544
Bifurcation	251 (6.4)	33 (4.7)	0.118
Diagnostic study			
FFR	94 (2.4)	10 (1.4)	0.156
IVUS	488 (12.4)	80 (11.5)	0.551
OCT	127 (3.2)	24 (3.5)	0.846
Number of stents	3.6±1.0	3.5±0.57	0.786
Introducer sheath size			<0.001
4Fr	513 (13.0)	100 (14.3)	
5Fr	1,478 (37.3)	326 (46.8)	
6Fr	1,742 (44.1)	249 (35.7)	
7Fr	105 (2.7)	7 (1.0)	
Sheathless 6.5 Fr	109 (2.8)	15 (2.2)	
Large sheath (≥6 Fr)	1,742 (44.1)	249 (35.7)	<0.001
Hemostasis method in DRA			<0.001
Gauze plug with adhesive tape fixation	2,086 (52.9)	330 (47.3)	
Elastic bandage wrapping	1,827 (46.3)	354 (50.8)	
Compression device	13 (0.3)	10 (1.4)	
Manual compression	21 (0.5)	3 (0.4)	

Values are presented as mean ± standard deviation or number (%). Sheath size refers to largest size used for coronary procedure.
CAG = coronary angiography; CTO = chronic total occlusion; DRA = distal radial access; FFR = fractional flow reserve; IVUS = intravascular ultrasonography; OCT = optical coherence tomography; PCI = percutaneous coronary intervention; US = ultrasound.

Efficacy outcomes

The efficacy outcomes of this study comparing the anatomical snuffbox approach with the dorsum of the hand approach in patients who underwent DRA are presented in **Table 3**. The DRA via the anatomical snuffbox was associated with a significantly higher rate of puncture success compared to DRA via the dorsum of the hand (95.1% vs. 90.5%, p<0.001), and a lower rate of access-site crossover for coronary procedures (1.0% vs. 2.1%, p=0.009). However, the puncture time was significantly longer in the anatomical snuffbox compared to that on the dorsum of the hand, with a median value of 60 (31–120) versus 43 (22–100) seconds, respectively (p<0.001). In addition, the 0.014-inch guidewires were more frequently used in DRA on the dorsum of the hand (11.6% vs. 5.3%, p<0.001).

Table 3. Efficacy and safety outcomes according to access site

Outcomes	Anatomical snuffbox	Dorsum of the hand	p value
Efficacy outcomes (n=4,977)	n=4.190	n=787	
Primary efficacy endpoint	3947 (94.2)	697 (88.6)	<0.001
Puncture success	3,986 (95.1)	712 (90.5)	<0.001
Puncture times (second)	60 (31–120)	43 (22–100)	<0.001
Access times (second)	110 (68–180)	87 (58–154)	<0.001
Use of 014 guidewire	221 (5.3)	91 (11.6)	<0.001
In puncture success (n=4,698)	n=3,986	n=712	
Crossover for coronary procedure	39 (1.0)	15 (2.1)	0.009
Reasons for crossover			
Vessel tortuosity	16 (0.4)	4 (0.6)	0.545
Need for large catheter	8 (0.2)	4 (0.6)	0.079
Vasospasm	6 (0.2)	2 (0.3)	0.437
Conduit vessel occlusion	4 (0.1)	3 (0.4)	0.041
Small vessel	6 (0.2)	0 (0.0)	0.3
Complication related	3 (0.1)	1 (0.1)	0.583
Unstable vital sign	1 (0.0)	1 (0.2)	0.169
Others	6 (0.2)	5 (0.7)	0.005
Total procedure time (minute)	42 (27–61)	39 (29–54)	0.156
CAG time (minute)	7 (4–12)	7 (4.3–12)	0.076
PCI time (minute)	32 (20–49)	30 (19.5–45.8)	0.239
Safety outcomes (n=4,644)	n=3,947	n=697	
Primary safety endpoint	132 (3.3)	18 (2.6)	0.294
Modified EASY type Ia	125 (3.2)	18 (2.6)	
Modified EASY type Ib-III	7 (0.2)	0 (0.0)	
Modified EASY type IV or V	0 (0.0)	0 (0.0)	
BARC type 1	42 (1.1)		
BARC type 2	90 (2.3)	11 (1.6)	
BARC type 3–5	0 (0.0)	0 (0.0)	
Hemostasis time (minute)	201.5±142.9	178±82.8	<0.001
Large sheath (≥6 Fr)	229.5±178.7	189.2±125.7	<0.001
Prolonged hemostasis >180 min	792 (20.1)	10 (1.4)	<0.001
Any access-site complication at discharge	220 (5.6)	24 (3.4)	0.021
Access-site bleeding	139 (3.5)	20 (2.9)	0.430
DRA occlusion	16 (0.4)	0 (0)	0.092
RA occlusion	8 (0.2)	0 (0)	0.234
Tenderness	73 (1.8)	5 (0.7)	0.032
Hand edema	68 (1.7)	7 (1)	0.165
Numbness	11 (0.3)	4 (0.6)	0.205
Perforation	7 (0.2)	0 (0.0)	0.266
Dissection	8 (0.2)	1 (0.1)	0.743
Recompression due to bleeding	157 (4.0)	15 (2.2)	0.019

Values are mean ± standard deviation or number (%) or median (interquartile range). Large sheath was defined as ≥6 French size.
DRA = distal radial artery; EASY = early discharge after transradial stenting of coronary arteries; MACCE = major adverse cardiac and cerebrovascular events; RA = radial artery.

There were no significant differences in procedure times between the two groups. The primary efficacy endpoint, defined as successful puncture with completion of the coronary procedure without access-site crossover, was significantly higher in the anatomical snuffbox approach compared to the dorsum of the hand approach (94.2% vs. 88.6%, p<0.001). The subgroup analysis for the primary efficacy endpoint demonstrated that, across most subgroups, anatomical snuffbox access consistently yielded a higher hazard of achieving the endpoint, with no statistically significant interactions (all p for interaction >0.05). However, significant interaction was observed between puncture location and pulse status for the primary efficacy endpoint (p for interaction <0.001; **Supplementary Figure 1**).

Safety outcomes

The safety outcomes were evaluated in 4,644 patients who underwent coronary procedures without any access-site crossover following successful puncture via DRA. Overall safety outcomes according to access site are presented in **Table 3**. The primary safety endpoint, defined as the occurrence of DRA-related bleeding was numerically higher in the anatomical snuffbox approach (3.3%) compared to the dorsum of the hand approach (2.6%), but the difference was not statistically significant (p=0.294). There were no major bleeding events, defined as BARC type 3 or 5, in patients who underwent coronary procedures through the DRA. The time to hemostasis was significantly longer in the anatomical snuffbox approach compared to the dorsum of the hand approach (201.5±142.9 minutes vs. 178.0±82.8 minutes, p<0.001). Notably, even when comparing sheath sizes of 6 or 7 Fr, more time was required to achieve hemostasis with the anatomical snuffbox approach. Prolonged hemostasis >180 minutes, a secondary endpoint of this trial, was significantly lower in DRA on the dorsum of the hand than in the anatomical snuffbox (1.4% vs. 20.1%, p<0.001). Additionally, the rate of recompression for the hemostasis was higher in the anatomical snuffbox approach than in the dorsum of the hand approach (4.0% vs. 2.2%, p=0.019). Further analyses to assess the clinical impact of prolonged hemostasis demonstrated a higher overall rate of access-site complications, although no individual complication reached statistical significance (**Supplementary Table 1**). Any access-site complications at discharge were significantly lower in DRA on the dorsum of the hand compared to DRA in the anatomical snuffbox (5.6% vs. 3.4%, p=0.021). There were no reported occlusions in the radial or distal radial artery with the dorsum of the hand approach, whereas the anatomical snuffbox approach exhibited incidences of DRAO and RAO at rates of 0.4% and 0.2%, respectively.

The subgroup analysis for the primary safety endpoint was performed, and the results were presented in **Supplementary Figure 2**. Across most subgroups, there were no statistically significant interactions (all p for interaction >0.05). However, a significant interaction was observed in patients who underwent PCI (p for interaction=0.036).

Association between puncture location and outcomes

We investigated predictive factors influencing the efficacy and safety outcomes. The primary efficacy endpoint, defined as completion of the coronary procedure without access-site crossover following successful puncture of the distal radial artery, was associated with the anatomical snuffbox approach, female sex, weak pulse, low experience of DRA (<100 cases) and AMI in the univariate analysis. The multivariable logistic regression analysis demonstrated that the anatomical snuffbox approach was significantly and independently associated with a higher success rate of puncture and coronary procedure without access-site crossover (OR, 2.358; 95% CI, 1.800–3.090; p<0.001). In contrast, weak pulse, low experience of DRA (<100 cases), and AMI were independently associated with a lower success rate for the primary efficacy endpoint (**Table 4**). Regarding the primary safety endpoint, there was no significant difference in DRA-related bleeding between the anatomical snuffbox approach and the dorsum of the hand approach (OR, 1.305; 95% CI, 0.792–2.150; p=0.296). Age, female sex, loading of P2Y12 inhibitors, and PCI were independently associated with a higher rate of DRA-related bleeding, while the use of a large sheath or heparin did not affect the primary safety endpoint in the multivariable logistic regression analysis (**Table 5**). Regarding secondary outcomes, DRA via the anatomical snuffbox was identified as an independent factor for puncture success (OR, 2.358; 95% CI, 1.800–3.090; p<0.001) and prolonged hemostasis >180 minutes (OR, 15.002; 95% CI, 7.708–29.197; p<0.001).

Table 4. Factors associated with primary efficacy endpoint

Variables	Univariable			Multivariable		
	OR	95% CI	p value	OR	95% CI	p value
Age	1.005	0.996–1.014	0.280	1.006	0.996–1.016	0.269
Female	0.775	0.616–0.975	0.029	0.805	0.629–1.031	0.085
BMI ≥25	0.98	0.784–1.224	0.859	-	-	-
Hypertension	1.084	0.862–1.363	0.492	-	-	-
Diabetes mellitus	0.953	0.758–1.199	0.681	-	-	-
CKD	1.11	0.710–1.734	0.648	-	-	-
Dyslipidemia	0.811	0.645–1.019	0.072	-	-	-
Current smoker	0.933	0.717–1.215	0.609	-	-	-
Prior MI	1.365	0.929–2.007	0.113	-	-	-
Prior PCI	0.968	0.748–1.254	0.807	-	-	-
AMI	0.688	0.520–0.910	0.009	0.6	0.447–0.804	0.001
DRA experience <100 cases	0.531	0.422–0.666	<0.001	0.403	0.316–0.513	<0.001
Anatomical snuffbox	2.097	1.625–2.705	<0.001	2.358	1.800–3.090	<0.001
Weak pulse	0.214	0.169–0.270	<0.001	0.195	0.153–0.249	<0.001
Open steel needle	0.91	0.727–1.140	0.414	-	-	-

AMI = acute myocardial infarction; BMI = body mass index; CI = confidence interval; CKD = chronic kidney disease; DRA = distal radial access, MI = myocardial infarction; OR = odds ratio; PCI = percutaneous coronary intervention.

Table 5. Factors associated with primary safety endpoint

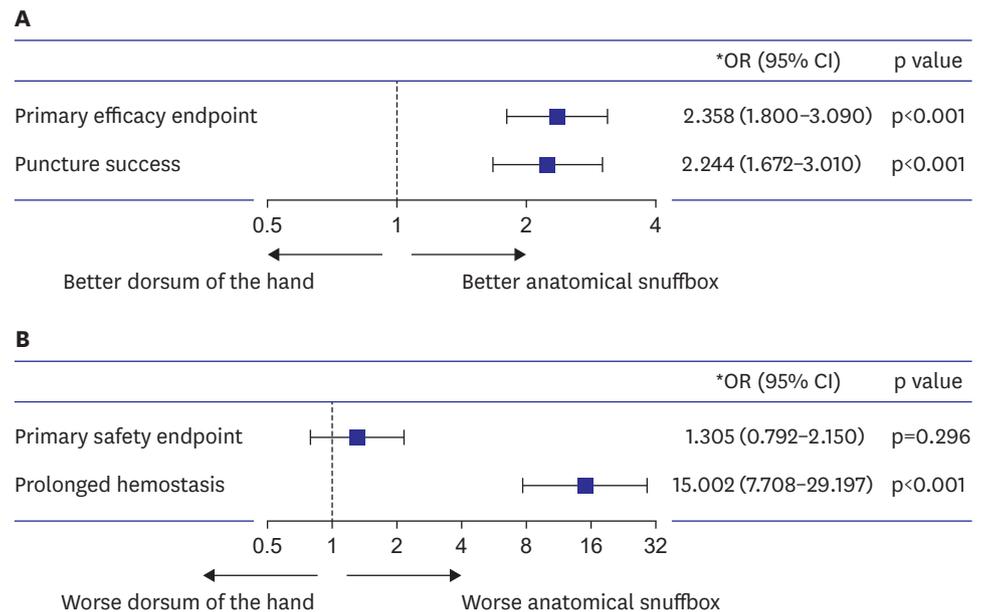| Variables	Univariable			Multivariable		
	OR	95% CI	p value	OR	95% CI	p value
Age	1.030	1.015–1.046	<0.001	1.017	1.001–1.034	0.033
Female	2.063	1.489–2.859	<0.001	2.069	1.450–2.952	<0.001
BMI ≥25	0.759	0.545–1.056	0.102	-	-	-
Hypertension	1.143	0.809–1.613	0.449	-	-	-
Diabetes mellitus	0.912	0.648–1.283	0.597	-	-	-
CKD	1.662	0.990–2.788	0.054	1.379	0.809–2.351	0.237
Dyslipidemia	1.023	0.736–1.421	0.894	-	-	-
Current smoker	0.571	0.358–0.910	0.019	0.759	0.454–1.267	0.291
Prior MI	1.283	0.809–2.035	0.290	-	-	-
Prior PCI	1.115	0.769–1.616	0.566	-	-	-
Acute MI	1.592	1.068–2.374	0.022	0.862	0.560–1.328	0.502
DRA experience <100 cases	1.101	0.768–1.578	0.602	-	-	-
Anatomical snuffbox	1.305	0.792–2.150	0.296	-	-	-
Weak pulse	1.099	0.693–1.741	0.689	-	-	-
Open steel needle	0.750	0.532–1.059	0.103	-	-	-
Use of Heparin	3.188	1.174–8.659	0.023	1.496	0.536–4.174	0.441
Aspirin loading	1.768	1.243–2.514	0.002	0.746	0.421–1.322	0.315
P2Y12 inhibitor loading	2.170	1.499–3.140	<0.001	1.881	1.030–3.433	0.040
Elastic bandage use	1.073	0.775–1.486	0.671	-	-	-
PCI	3.620	2.576–5.089	<0.001	3.047	1.975–4.702	<0.001
Large sheath	2.512	1.788–3.530	<0.001	1.400	0.940–2.086	0.098

Large sheath indicates use of above 6 Fr sheath.
BMI = body mass index; CI = confidence interval; CKD = chronic kidney disease; DRA = distal radial access, MI = myocardial infarction; OR = odds ratio; PCI = percutaneous coronary intervention.

The results of the multivariable logistic regression analysis regarding the association between DRA and each endpoint are summarized in **Figure 3**.

DISCUSSION

The main findings of this trial, which compared the efficacy and safety of DRA in the anatomical snuffbox and on the dorsum of the hand based on a large-scale prospective multicenter registry of 4,977 patients, can be summarized as follows: 1) the anatomical snuffbox approach significantly increased the success rate of puncture and coronary

A

	*OR (95% CI)	p value
Primary efficacy endpoint	2.358 (1.800–3.090)	p<0.001
Puncture success	2.244 (1.672–3.010)	p<0.001

0.5 1 2 4

Better dorsum of the hand Better anatomical snuffbox

B

	*OR (95% CI)	p value
Primary safety endpoint	1.305 (0.792–2.150)	p=0.296
Prolonged hemostasis	15.002 (7.708–29.197)	p<0.001

0.5 1 2 4 8 16 32

Worse dorsum of the hand Worse anatomical snuffbox

Figure 3. Summary of outcomes according to access site.
(A) Efficacy endpoints. (B) Safety endpoints. This summary figure illustrates forest plots of adjusted odds ratios for each outcome comparing anatomical snuffbox versus dorsum of the hand in distal radial access using a multicenter KODRA registry.
CI = confidence interval; OR = odds ratio.
*OR indicates adjusted OR.

procedure without access-site crossover compared to the dorsum of the hand approach; 2) DRA-related bleeding was similar regardless of puncture location; 3) access via the anatomical snuffbox was independently associated with prolonged hemostasis >180 minutes, yet with a higher puncture success rate.

TRA is currently recommended over transfemoral access (TFA) to reduce bleeding and vascular complications for coronary procedure, and even mortality in acute coronary syndrome patients.[11-13] This endorsement is based on compelling evidence from large randomized controlled trials (RCTs) and meta-analyses showing clinical benefits over TFA.[14-19] Despite its advantages, RAO remains the most common and significant vascular complication in TRA.[19)20] The feasibility and safety of DRA have been proven through several registry trials.[8)21-23] Recent RCTs and meta-analysis comparing DRA to TRA have demonstrated that DRA not only shows similar efficacy in terms of successful puncture and coronary procedures including complex PCI, but also reduces RAO rates and access-site complications.[1-6]

The distal radial artery in the anatomical snuffbox and on the dorsum of the hand has different anatomical features in its course and adjacent structures, which may affect the safety and efficacy of DRA during coronary procedures and hemostasis. In the anatomical snuffbox, the artery is located deeply between two tendons and lies above the scaphoid and trapezium bones. In contrast, the artery on the dorsum of the hand courses superficially, running beneath the extensor pollicis longus tendon.[7] Additionally, its diameter may be smaller than that in the anatomical snuffbox because it is located more distally, as the distal radial artery is known to have a smaller diameter than the more proximal segments of the radial artery.[24]

This is the first study that compares the efficacy and safety of DRA in the anatomical snuffbox and on the dorsum of the hand using large registry data. In terms of efficacy, the anatomical snuffbox approach showed better outcomes for puncture success and successful coronary procedures without access-site crossover. A larger arterial diameter and a smaller sheath-to-artery diameter ratio are contributing factors for puncture success and successful coronary procedures without crossover.[25)26)] The proximal part of the artery usually has a larger diameter than the distal part, and the anatomical snuffbox approach could increase the success rate of punctures and coronary procedures without the need for crossover, compared to the dorsum of the hand approach. Additionally, in terms of the lower puncture success rates and more frequent use of 0.014-inch guidewires, the superficial location of the artery on the dorsum of the hand suggests that a vertical needle angle could make advancing the guidewire more challenging, even after a successful arterial puncture. Interestingly, puncture in the anatomical snuffbox required more time despite its higher success rate. The possible explanation is that anatomical differences and accumulated experience might lead operators to continue attempting punctures in the anatomical snuffbox, rather than switching to another access site.

In terms of safety outcomes, DRA on the dorsum of the hand was comparable to the anatomical snuffbox. Although there was no difference in DRA-related bleeding, access on the dorsum of the hand was independently associated with a lower incidence of prolonged hemostasis. It also showed a shorter time to hemostasis and lower overall access-site complications. DRA may have beneficial effects on time to hemostasis, as suggested by prior reports.[3)4)] However, comparative data based on the puncture site within DRA have been lacking. This study demonstrated that the dorsum of the hand approach was associated with more favorable hemostasis outcomes, including a lower incidence of prolonged hemostasis (1.4% vs. 20.1%). A previous meta-analysis of RCTs demonstrated substantial variability in mean hemostasis times across studies, with reported durations of up to 249.1 minutes[2)]. In the present study, the median and mean hemostasis times were 180 and 192 minutes, respectively, which are comparable to those reported in earlier RCTs, despite the relatively high prevalence of prolonged hemostasis observed in the anatomical snuffbox group. The variability in time to hemostasis may be attributable to the absence of a standardized protocol, and differences in the operator experience with DRA, procedural characteristics, definition of hemostasis. The beneficial effect on hemostasis observed with the dorsum of the hand approach may be partly attributed to anatomical differences in the location of the distal radial artery. The artery on the dorsum of the hand is more superficial, allowing for more effective compression during hemostasis. Additionally, the artery in the anatomical snuffbox is surrounded by two tendons, making compression more susceptible to disruption by unexpected patient's thumb movement. Longer time to hemostasis and prolonged compression have been identified as risk factors for RAO in previous studies,[20)27)] potentially accounting for the absence of DRAO and RAO in this trial.

Experience with DRA in over 100 cases demonstrated not only a higher success rate for the efficacy endpoints but also lower incidence of prolonged hemostasis. Although experience with DRA is recognized as an important factor for puncture success,[8)28)] our study notably reveals that the operator's experience is also crucial during the hemostasis period for ensuring safety outcomes. A standard method for achieving hemostasis after DRA has not yet been established. This study lacked a standardized protocol for hemostasis, which might have contributed to different outcomes in hemostasis depending on the operator's experience.

Ultrasound-guided puncture was performed in only 6.4% of cases in this registry, despite an overall high puncture success rate of 94.4%. Ultrasound-guided puncture has become a popular technique for enhancing puncture-related outcomes.[7]29) In an RCT comparing ultrasound-guided to tactile-guided puncture in DRA, ultrasound guidance increased the puncture success rate from 87% to 97%.[30] Given the potential increase in puncture success with the use of ultrasound in DRA on the dorsum of the hand, and the results of this trial, it may serve as a safer primary access route for coronary procedures in DRA, particularly in patients with a high bleeding risk. In contrast, DRA on the anatomical snuffbox may be a more favorable access option in patients with a weak pulse or AMI, and for operators with limited DRA experience.

The current study has several limitations that need to be addressed. First, this is a prospective registry study, and patients with weak or non-palpable pulses were excluded. Selection bias should be considered when interpreting the findings of this study. Second, the use of ultrasound for puncture was low, at only 6.4%. In DRA or TRA, ultrasound-guided puncture is not mandatory, but it may potentially increase the success rate of puncture. Therefore, the lower puncture success rates observed with DRA on the dorsum of the hand in this study might differ if ultrasound guidance had been used more frequently. Third, there were differences in the number of study participants, baseline characteristics, and procedural variables. Therefore, the results of this trial should be interpreted with caution when generalizing to routine clinical practice. However, this is an inherent limitation of registry-based studies. To address these differences, multivariable logistic regression and subgroup analyses were performed to adjust for potential confounders and derive the study findings. Fourth, RAO and DRAO were assessed using palpation rather than ultrasound, which might have obscured the exact incidence of arterial occlusion.

In this analysis of a large-scale prospective multicenter registry, DRA via the anatomical snuffbox demonstrated a higher success rate for puncture with completion of coronary procedures without access-site crossover. However, it was associated with a higher incidence of prolonged hemostasis, without an increased risk of DRA-related bleeding. Further research is needed to improve the safety and efficacy outcomes of DRA, and randomized clinical trials are also warranted to determine the optimal access site for DRA.

SUPPLEMENTARY MATERIALS

Supplementary Table 1
Access-Site complications in patients with and without prolonged hemostasis

Supplementary Figure 1
Subgroup analysis for interaction with primary efficacy endpoint.

Supplementary Figure 2
Subgroup analysis for interaction with primary safety endpoint.

REFERENCES

1. Eid-Lidt G, Rivera Rodríguez A, Jimenez Castellanos J, Farjat Pasos JI, Estrada López KE, Gaspar J. Distal radial artery approach to prevent radial artery occlusion trial. *JACC Cardiovasc Interv* 2021;14:378-85.
   PUBMED | **CROSSREF**

2. Ferrante G, Condello F, Rao SV, et al. Distal vs conventional radial access for coronary angiography and/or intervention: a meta-analysis of randomized trials. *JACC Cardiovasc Interv* 2022;15:2297-311. **PUBMED** | **CROSSREF**

3. Aminian A, Sgueglia GA, Wiemer M, et al. Distal versus conventional radial access for coronary angiography and intervention: the DISCO RADIAL trial. *JACC Cardiovasc Interv* 2022.15:1191-201. **PUBMED** | **CROSSREF**

4. Tsigkas G, Papageorgiou A, Moulias A, et al. Distal or traditional transradial access site for coronary procedures: a single-center, randomized study. *JACC Cardiovasc Interv* 2022;15:22-32. **PUBMED** | **CROSSREF**

5. Chen T, Li L, Li F, et al. Comparison of long-term radial artery occlusion via distal vs. conventional transradial access (CONDITION): a randomized controlled trial. *BMC Med* 2024;22:62. **PUBMED** | **CROSSREF**

6. Gasparini GL, Garbo R, Gagnor A, Oreglia J, Mazzarotto P. First prospective multicentre experience with left distal transradial approach for coronary chronic total occlusion interventions using a 7 Fr Glidesheath Slender. *EuroIntervention* 2019;15:126-8. **PUBMED** | **CROSSREF**

7. Sgueglia GA, Lee BK, Cho BR, et al. Distal radial access: consensus report of the first Korea-Europe transradial intervention meeting. *JACC Cardiovasc Interv* 2021;14:892-906. **PUBMED** | **CROSSREF**

8. Lee JW, Kim Y, Lee BK, et al. Distal radial access for coronary procedures in a large prospective multicenter registry: the KODRA trial. *JACC Cardiovasc Interv* 2024;17:329-40. **PUBMED** | **CROSSREF**

9. Bertrand OF, De Larochellière R, Rodés-Cabau J, et al. A randomized study comparing same-day home discharge and abciximab bolus only to overnight hospitalization and abciximab bolus and infusion after transradial coronary stent implantation. *Circulation* 2006;114:2636-43. **PUBMED** | **CROSSREF**

10. Mehran R, Rao SV, Bhatt DL, et al. Standardized bleeding definitions for cardiovascular clinical trials: a consensus report from the Bleeding Academic Research Consortium. *Circulation* 2011;123:2736-47.
    PUBMED | **CROSSREF**

11. Neumann FJ, Sousa-Uva M, Ahlsson A, et al.; ESC Scientific Document Group. 2018 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J* 2019;40:87-165. **PUBMED** | **CROSSREF**

12. Lawton JS, Tamis-Holland JE, Bangalore S, et al. 2021 ACC/AHA/SCAI Guideline for Coronary Artery Revascularization: a report of the American College of Cardiology/American Heart Association Joint Committee on Clinical Practice Guidelines. *Circulation* 2022;145:e18-114. **PUBMED** | **CROSSREF**

13. Buske M, Feistritzer HJ, Jobs A, Thiele H. Management of acute coronary syndrome : ESC guidelines 2023. *Herz* 2024;49:5-14. **PUBMED** | **CROSSREF**

14. Vranckx P, Frigoli E, Rothenbühler M, et al. Radial versus femoral access in patients with acute coronary syndromes with or without ST-segment elevation. *Eur Heart J* 2017;38:1069-80. **PUBMED** | **CROSSREF**

15. Valgimigli M, Gagnor A, Calabró P, et al. Radial versus femoral access in patients with acute coronary syndromes undergoing invasive management: a randomised multicentre trial. *Lancet* 2015;385:2465-76.
    PUBMED | **CROSSREF**

16. Le May M, Wells G, So D, et al. Safety and efficacy of femoral access vs radial access in ST-segment elevation myocardial infarction: the SAFARI-STEMI randomized clinical trial. *JAMA Cardiol* 2020;5:126-34.
    PUBMED | **CROSSREF**

17. Jolly SS, Yusuf S, Cairns J, et al.; RIVAL trial group. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. *Lancet* 2011;377:1409-20. **PUBMED** | **CROSSREF**

18. Ferrante G, Rao SV, Jüni P, et al. Radial versus femoral access for coronary interventions across the entire spectrum of patients with coronary artery disease: a meta-analysis of randomized trials. *JACC Cardiovasc Interv* 2016;9:1419-34. **PUBMED** | **CROSSREF**

19. Rashid M, Kwok CS, Pancholy S, et al. Radial artery occlusion after transradial interventions: a systematic review and meta-analysis. *J Am Heart Assoc* 2016;5:e002686. **PUBMED** | **CROSSREF**

20. Bernat I, Aminian A, Pancholy S, et al. Best practices for the prevention of radial artery occlusion after transradial diagnostic angiography and intervention: an international consensus paper. *JACC Cardiovasc Interv* 2019;12:2235-46. **PUBMED** | **CROSSREF**

21. Kim Y, Ahn Y, Kim I, et al. Feasibility of coronary angiography and percutaneous coronary intervention via left snuffbox approach. *Korean Circ J* 2018;48:1120-30. **PUBMED** | **CROSSREF**

22. Lee JW, Park SW, Son JW, Ahn SG, Lee SH. Real-world experience of the left distal transradial approach for coronary angiography and percutaneous coronary intervention: a prospective observational study (LeDRA). *EuroIntervention* 2018;14:e995-1003. **PUBMED** | **CROSSREF**

23. Kiemeneij F. Left distal transradial access in the anatomical snuffbox for coronary angiography (ldTRA) and interventions (ldTRI). *EuroIntervention* 2017;13:851-7. **PUBMED** | **CROSSREF**

24. Lee JW, Son JW, Go TH, et al. Reference diameter and characteristics of the distal radial artery based on ultrasonographic assessment. *Korean J Intern Med* 2022;37:109-18. **PUBMED** | **CROSSREF**

25. Horie K, Tada N, Isawa T, et al. A randomised comparison of incidence of radial artery occlusion and symptomatic radial artery spasm associated with elective transradial coronary intervention using 6.5 Fr SheathLess Eaucath Guiding Catheter vs. 6.0 Fr Glidesheath Slender. *EuroIntervention* 2018;13:2018-25. **PUBMED** | **CROSSREF**

26. Li SS, Li JM, Liu LL, Liu W, Yang H, Feng CG. Analysis of the risk factors related to the success rate of distal transradial artery access in patients with coronary heart disease. *Risk Manag Healthc Policy* 2022;15:657-63. **PUBMED** | **CROSSREF**

27. Maqsood MH, Pancholy S, Tuozzo KA, Moskowitz N, Rao SV, Bangalore S. Optimal hemostatic band duration after transradial angiography or intervention: insights from a mixed treatment comparison meta-analysis of randomized trials. *Circ Cardiovasc Interv* 2023;16:e012781. **PUBMED** | **CROSSREF**

28. Roh JW, Kim Y, Lee OH, et al. The learning curve of the distal radial access for coronary intervention. *Sci Rep* 2021;11:13217. **PUBMED** | **CROSSREF**

29. Hadjivassiliou A, Kiemeneij F, Nathan S, Klass D. Ultrasound-guided access to the distal radial artery at the anatomical snuffbox for catheter-based vascular interventions: a technical guide. *EuroIntervention* 2021;16:1342-8. **PUBMED** | **CROSSREF**

30. Mori S, Hirano K, Yamawaki M, et al. A comparative analysis between ultrasound-guided and conventional distal transradial access for coronary angiography and intervention. *J Interv Cardiol* 2020;2020:7342732. **PUBMED** | **CROSSREF**