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ORIGINAL ARTICLE

Importance of measurement of the diameter of the distal radial artery in a distal radial approach from the anatomical snuffbox before coronary catheterization

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Abstract

Coronary catheterization by a distal radial approach at the site of the anatomical snuffbox has recently been reported to be both safe and useful. No data are available on the diameter of the distal radial artery (DRA) in Japan, and it is unclear whether the DRA is large enough to withstand the insertion of a conventional sheath by a traditional radial approach. We enrolled 142 patients who underwent coronary catheterization and evaluated the vessel diameter of the DRA using ultrasound. The vessel diameter of the DRA in the anatomical snuffbox (2.6 ± 0.5 mm) was significantly smaller than that of the proximal radial artery (PRA) at the conventional puncture site (3.1 ± 0.4 mm). The difference in vessel diameter between the DRA and PRA was 0.5 ± 0.4 mm, and the DRA/PRA ratio was 0.8 ± 0.1. Although the vessel diameter of the DRA was positively correlated with that of the PRA ($r = 0.66$, $p < 0.0001$), in some cases the DRA was extremely small compared to the PRA. When the vessel diameter of the DRA is smaller than the outer diameter of the sheath scheduled for use, we should puncture the PRA at the outset. We could perform coronary catheterization by a distal radial approach without major bleeding or adverse events, and there was no radial artery occlusion at the site of the anatomical snuffbox or the forearm. For coronary catheterization by a distal radial approach, we should evaluate whether there is sufficient vessel diameter using ultrasound before the procedure. In addition, this approach can be an effective option from the viewpoint of radial artery preservation.

Keywords Anatomical snuffbox · Distal radial artery · Radial approach · Coronary catheterization · Adverse events

Introduction

Coronary catheterization via the distal radial artery (DRA) at the site of the anatomical snuffbox has recently been reported to be both safe and useful for coronary angiography (CAG) and percutaneous coronary intervention (PCI) [1]. The anatomical snuffbox is surrounded by the extensor pollicis longus, the extensor pollicis brevis, and the extensor retinaculum. The distal part of the radial artery passes through this region. After puncture at the DRA and insertion of a sheath, the operator can perform the procedure as in a femoral artery approach, and does not need to bend over the patient to reach the left radial artery. For the patient, the left arm is in a more comfortable position during the procedure than with a traditional left radial approach. Furthermore, a right-handed patient can use their right arm after the procedure. Kiemeneij et al. reported that another important advantage is a reduction of the risk of radial artery occlusion at the site of the proximal radial artery (PRA) by a

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traditional radial approach [1]. DRA is considered to be an effective option, regardless of whether it is performed on the left or right side, from the viewpoint of radial artery preservation. Lee et al. reported that the vessel diameter of the left PRA at the conventional puncture site was 3.1 ± 0.4 mm, while that of the left DRA in the anatomical snuffbox was 2.41 ± 0.50 mm [2]. In Japan, Naito et al. reported that the vessel diameter of the DRA was 2.04 ± 0.43 mm in males and 1.96 ± 0.44 mm in females, respectively [3]. However, there is no large-scale clinical report, and it is unclear whether the DRA is large enough to withstand the insertion of a conventional sheath by a traditional radial approach. Therefore, we evaluated the vessel diameter of the DRA using ultrasound for patients who underwent CAG or PCI.

Methods and subjects

We enrolled 142 patients who underwent coronary catheterization and evaluated the vessel diameter of the DRA in the anatomical snuffbox and of the PRA at the conventional puncture site using ultrasound from November 2017 to October 2018 at Izumi General Medical Center. The pseudo-adventitial distance was used as the vessel diameter; i.e., the distance from the lower edge of the adventitia of the vessel proximal wall to the upper edge of the adventitia of the vessel distal wall (Fig. 1). To eliminate measurement errors, all measurements were performed by one ultrasound-dedicated laboratory technician. Generally, we measured the vessel diameter of the right radial artery. However, for cases in which the right PRA was not palpable, we measured the vessel diameter of the left radial artery. Patients in whom we could not palpate the PRA on either side and patients undergoing hemodialysis were excluded. The protocol in this study was approved by the ethics committee of Izumi General Medical Center. We retrospectively collected all of the data and performed a post hoc analysis using the database of Izumi General Medical Center.

Statistical analysis

The statistical analysis was performed using StatView 5.0 (SAS Institute Inc., Cary, NC) at Izumi General Medical Center. Continuous variables are shown as the mean ± standard deviation. Continuous variables were compared between the groups by the unpaired *t* test. The Spearman rank correlation coefficient was used to evaluate associations between the groups. A value of $p < 0.05$ was considered significant.

Results

Measurement of DRA and PRA in all patients, males and females

Table 1 shows the data regarding DRA and PRA in all patients, males and females. The numbers of all patients, males and females were 142, 96 and 46, respectively. The vessel diameter of the DRA in the anatomical snuffbox (2.6 ± 0.5 mm) was significantly smaller than that of the PRA at the conventional puncture site (3.1 ± 0.4 mm) in all patients. A similar result was seen for both males and females. In all patients, the difference in vessel diameter between the DRA and PRA was 0.5 ± 0.4 mm, and the DRA/PRA ratio was 0.8 ± 0.1 The diameter of the DRA in females (2.5 ± 0.4 mm) tended to be smaller than that in males (2.6 ± 0.5 mm) ($p = 0.08$).

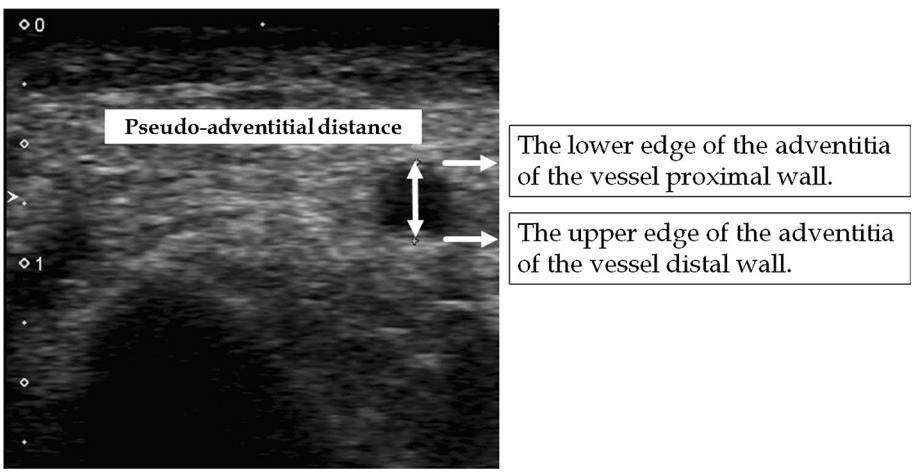

Fig. 1 Measurement of vessel diameter of the radial artery

Table 1 Measurement of DRA and PRA in all patients, males and females

	All ($n=142$)	Males ($n=96$)	Females ($n=46$)
PRA (mm)	3.1 ± 0.4	3.2 ± 0.4	3.0 ± 0.4
Median (mini–max)	3.1 (2.0–4.3)	3.1 (2.3–4.3)	3.0 (2.0–3.9)
DRA (mm)	2.6 ± 0.5*	2.6 ± 0.5*	2.5 ± 0.5*
Median (mini–max)	2.6 (1.1–3.9)	2.6 (1.2–3.9)	2.4 (1.1–3.1)
PRA-DRA (mm)	0.5 ± 0.4	0.5 ± 0.4	0.5 ± 0.4
(mini–max)	(0.0–1.9)	(0.0–1.9)	(0.0–1.4)
DRA/PRA	0.8 ± 0.1	0.8 ± 0.1	0.8 ± 0.1
(mini–max)	(0.4–1.0)	(0.4–1.0)	(0.5–1.0)

DRA distal radial artery, *PRA* proximal radial artery

*$p<0.0001$ vs. PRA

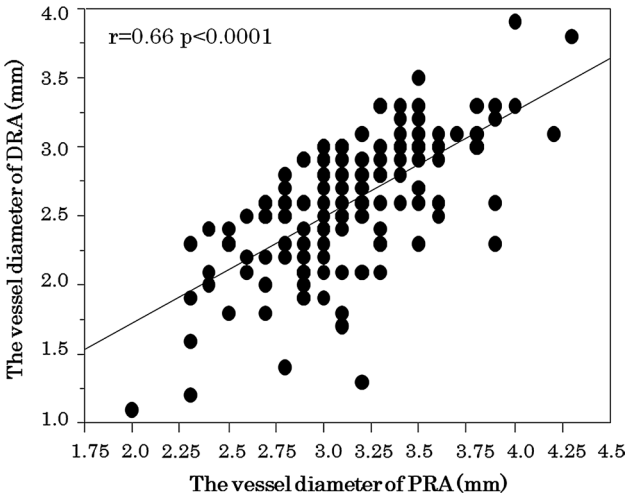

Fig. 2 Association between the vessel diameters of the distal radial artery (DRA) and proximal radial artery (PRA)

Associations between the vessel diameter of the DRA and the vessel diameter of the PRA, age, height, body weight (BW) and body mass index (BMI)

The vessel diameter of the DRA was positively correlated with that of the PRA ($r=0.66$, $p<0.0001$) (Fig. 2). The vessel diameter of the DRA was not correlated with age or height. On the other hand, the diameter of the DRA was positively correlated with both BW ($r=0.248$, $p=0.003$) and BMI ($r=0.228$, $p=0.007$) (Fig. 3).

Relationships between the outer diameter of a conventional sheath with a traditional radial approach and the diameters of the DRA and PRA

We compared the relationships between the outer diameter of a conventional sheath (Super Sheath™, MEDIKIT CO., LTD., Tokyo, Japan) using a traditional radial approach in our hospital and the diameters of the DRA and PRA (Fig. 4). The proportion of cases with a sheath outside diameter (SOD)/DRA ratio ≥ 1 was 6% at 4 Fr (1.88 mm), 23% at 5 Fr (2.20 mm), 45% at 6 Fr (2.5 mm), and 66% at 7 Fr (2.84 mm). On the other hand, the proportion of cases with a SOD/PRA ratio ≥ 1 was 0% at 4 Fr, 1% at 5 Fr, 9% at 6 Fr, and 23% at 7 Fr (Fig. 4). Thus, the proportion of patients in which a 5 Fr sheath was larger than the DRA was similar to that in which a 7 Fr sheath was larger than the PRA. By blindly inserting a conventional sheath using a traditional radial approach, operators may increase the risk of vascular injury, patient pain, and occlusion of the DRA. In addition, the conventional sheath (Super Sheath™, MEDIKIT CO., LTD., Tokyo, Japan) using our University Hospital and Glidesheath Slender® (Terumo Europe NV, Leuven, Belgium) which is frequently used as a slender sheath are

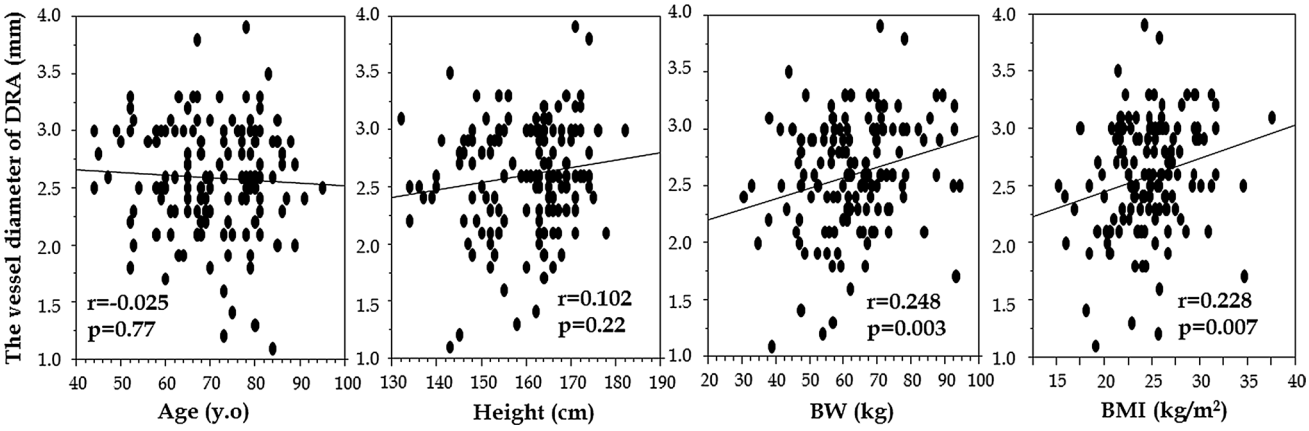

Fig. 3 Associations between the vessel diameter of the distal radial artery (DRA) and age, height, body weight (BW) and body mass index (BMI)

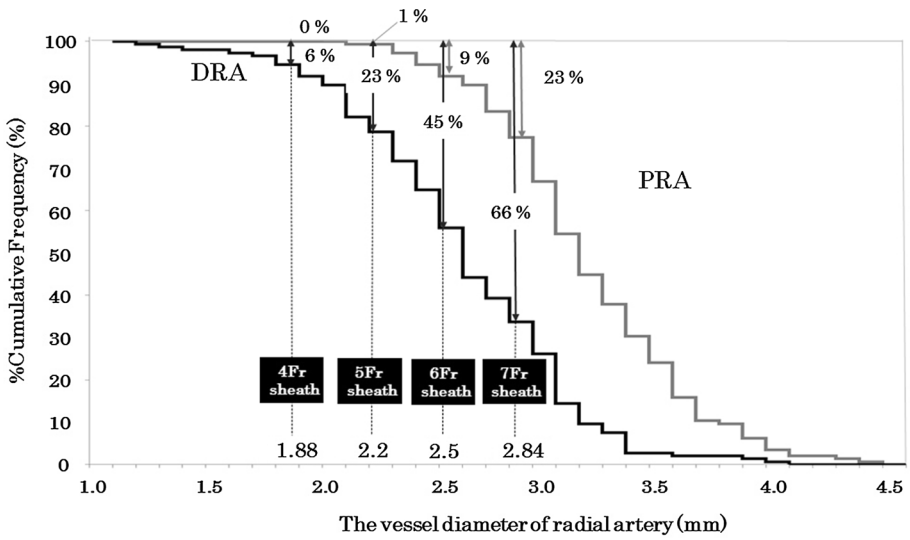

Fig. 4 Relationships between the outer diameter of a conventional sheath using a traditional radial approach and the diameters of the distal radial artery (DRA) and proximal radial artery (PRA)

almost the same sizes (5 Fr: 2.13 mm vs. 2.2 mm, 6 Fr: 2.46 mm vs. 2.5 mm. 7 Fr: 2.79 mm vs. 2.84 mm). In the analysis with Glidesheath Slender®, the proportion of cases with a SOD/DRA ratio ≥ 1 was 19% at 5 Fr, 37% at 6 Fr, and 61% at 7 Fr.

Patient, procedural and post-procedural characteristics in patients with a DRA procedure

After we checked to ensure that the vessel diameter of the DRA was larger than the outer diameter of the sheath scheduled for use, we performed distal radial puncture in 74 patients. Table 2 shows the patient, procedural and post-procedural characteristics in patients who underwent the DRA procedure. There were six procedural failures that required crossover to a traditional radial approach. The remaining 68 procedures were successful, without major bleeding or adverse events and no radial artery occlusion at the site of the anatomical snuffbox or the forearm.

Discussion

The vessel diameter of the DRA in the anatomical snuffbox was significantly smaller than that of the PRA at the conventional puncture site. Although the vessel diameter of the DRA was positively correlated with that of the PRA, in some cases the DRA was extremely small compared to the PRA. When the vessel diameter of the DRA is smaller than the outer diameter of the sheath scheduled for use, we should puncture the PRA at the outset.

Kiemeneij et al. reported that the DRA was occluded in 1.5% and the forearm radial artery was occluded in 0% of 62 patients who underwent a procedure involving a distal radial approach [1]. They considered that if the DRA in the snuffbox is occluded, antegrade flow through the superficial palmar arch is maintained. Therefore, a procedure via a distal radial approach does not cause forearm radial artery occlusion. Kaledin et al. reported that the DRA was

Table 2 Patient, procedural and post-procedural characteristics in patients with a DRA procedure

Patient characteristics ($n=74$)		Procedural characteristics ($n=68$)		Post-procedural characteristics ($n=68$)	
Male, *n* (%)	58 (78)	CAG only, *n* (%)	41 (60)	Major bleeding, *n* (%)	0 (0)
Age	70 ± 11	PCI, *n* (%)	27 (40)	Major adverse events, *n* (%)	0 (0)
BMI	25 ± 4	4 Fr conventional sheath, *n* (%)	48 (71)	Distal radial artery occlusion, *n* (%)	0 (0)
Right approach, *n* (%)	62 (84)	5 Fr conventional sheath, *n* (%)	4 (6)	Forearm radial artery occlusion, *n* (%)	0 (0)
STEMI, *n* (%)	0 (0)	6 Fr Glidesheath slender, *n* (%)	16 (23)		
UAP, *n* (%)	6 (8)	4 Fr or 5 Fr to 6 FrGlide, *n* (%)	11 (16)		
SAP, *n* (%)	46 (62)	Procedural time (min)	40 ± 36		
Other indication, *n* (%)	22 (30)	Fluoroscopy time (min)	19 ± 19		
Failure, *n* (%)	6 (8)	Contrast (ml)	46 ± 34		

DRA distal radial approach, *BMI* body mass index, *STEMI* ST elevated myocardial infarction, *UAP* unstable angina pectoris, *SAP* stable AP, *CAG* coronary angiography, *PCI* percutaneous coronary intervention

occluded in 1.5% of 656 patients, and no forearm radial artery occlusion was noted [4]. There is abundant evidence available regarding CAG and PCI by a traditional radial approach and this has been established as the default technique in Japan [5–7]. It has been reported to be both safe and useful not only in standby cases but also in cases of acute coronary syndrome [8, 9]. An unsolved problem with the traditional radial approach is radial artery occlusion (RAO) after the procedure. In the RAP and BEAT study, which compared the incidence of RAO between a 6 Fr Glidesheath Slender® (Terumo Europe NV, Leuven, Belgium) and a 5 Fr conventional sheath after CAG and PCI by a traditional radial approach, RAO occurred in 2.61% of 1926 patients. The incidence of RAO with the 6 Fr Glidesheath Slender® (3.47%) was greater than that with the 5 Fr conventional sheath (1.74%). A multivariate analysis revealed that predictors of RAO included use of a 6 Fr Glidesheath Slender®, pain during the procedure, patient age over 65 years, success of hemostasis, and oral administration of aspirin [10]. Thus, to reduce the risk of RAO, the hemostasis method should be improved and a sheath with the smallest diameter available for the procedure should be used. A distal radial approach is considered to be an effective option from the viewpoint of radial artery preservation. As described above, the vessel diameter of the DRA was significantly smaller than that of the PRA. The difference in vessel diameter between the DRA and PRA was 0.5 ± 0.4 mm, and the DRA/PRA ratio was 0.8 ± 0.1. Since women and patients with a low body weight are more likely to have a small vessel diameter, we have to be more careful in these cases. When we perform CAG or PCI by a distal radial approach, we should evaluate whether there is sufficient vessel diameter using ultrasound before the procedure. Gasparini et al. reported that it was feasible to insert a 7 Fr Glidesheath Slender for the DRA [11]. On the other hand, there is not enough data about distal radial approach. We need more useful data to assess the safety of use of large sheath for DRA. With the traditional radial approach, it has been reported that a sheath outer diameter/radial artery diameter ratio > 1 was associated with an increased incidence of blood flow disturbance after the procedure [12] and a sheath outer diameter/radial artery diameter ratio > 1 was an independent predictor of RAO [13, 14].

Therefore, we always need to evaluate the vessel diameter of the DRA using ultrasound before the procedure in our hospital. When the vessel diameter of the DRA is smaller than the outer diameter of the sheath scheduled for use, we should puncture the PRA rather than the DRA. In Japan, there is insufficient evidence regarding the usefulness of the distal radial approach, and there are many issues to consider. However, when used appropriately, the distal radial approach can be considered to be an effective option from the viewpoint of radial artery preservation, especially in patients who need dialysis access, artery grafting or multiple CAG and PCI procedures.

Study limitations

Since the vessel diameter of the DRA is very small and the radial artery is easily compressed by the echo probe, it may be difficult to accurately measure the vessel diameter. Therefore, even in the same patient, there is a possibility of a measurement error. In this study, to eliminate measurement errors, all measurements were performed by one ultrasound-dedicated laboratory technician. Since we excluded cases in which the operator judged that both proximal radial arteries were not palpable and patients undergoing dialysis, there is a possibility that the vessel diameter in actual clinical patients may be smaller than that in this patient group.

Conclusions

When we perform CAG and PCI by a distal radial approach, we should evaluate whether there is sufficient vessel diameter using ultrasound before the procedure. If the vessel diameter is too small, switching to the traditional radial approach or choosing a sheath with a smaller diameter may reduce the risk of vascular injury, unnecessary patient pain and radial artery occlusion.

Compliance with ethical standards

Conflict of interest We have no conflict of interest.

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