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ORIGINAL ARTICLE

Evaluation of the diameter of the distal radial artery at the anatomical snuff box using ultrasound in Japanese patients

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Abstract

Catheter angioplasty or angiography via the distal access point of the radial artery (dRA), located at the anatomical snuff box, is a less invasive strategy for coronary intervention attracting considerable attention. Determining the diameter of the dRA is necessary to minimize the risk of artery occlusion and safely perform catheter intervention. This was a retrospective observational study including patients who underwent coronary angiography or coronary intervention at Aomori Kyoritsu Hospital, Aomori, Japan, between February 2018 and August 2018. The diameter of the dRA and the conventional access point of the radial artery (cRA) at the wrist of the patients were measured using ultrasound prior to angiography or interventional procedure. A total of 120 patients were analyzed. In male patients, the diameters of the cRA and dRA were 2.62 ± 0.60 mm and 2.04 ± 0.43 mm, respectively. In females, these diameters were 2.44 ± 0.51 mm and 1.96 ± 0.44 mm, respectively. Overall, the dRA was statistically significantly smaller than the cRA. However, variations were observed, with eight patients (6.7%) having a larger dRA than cRA. The diameter of the dRA indicated only that of the cRA. A multivariate analysis did not reveal factors associated with vessel diameter. The size and anatomy of the dRA varied considerably. Thus, it is difficult to predict the actual diameter of the artery. Customized selection of the size of the sheath and site of intervention is essential for each patient to safely perform ultrasound examination prior to cannulation.

Keywords Distal radial artery · Radial artery occlusion · Less invasive strategy for coronary intervention

Introduction

Strategies for any medical treatment should be non/less invasive, effective, and safe. In coronary artery disease, the transradial intervention (TRI) approach has become the strategy of choice, owing to the comfort of patients after percutaneous coronary intervention and the reduced occurrence of complications (e.g., bleeding and death) compared with the transfemoral intervention approach [1–3]. However, the TRI approach is also characterized by serious challenges such as the risk of radial artery occlusion. Using a sheath with a larger diameter than that of the radial artery is a major risk factor of radial artery occlusion [4]. Recently, catheter angioplasty or angiography via the distal access point of the radial artery (dRA), located at the anatomical snuff box, has attracted considerable attention as a less invasive strategy than the conventional access point of the radial artery (cRA) at the wrist [5]. This technique improves comfort in patients, reduces the time to hemostasis and the occurrence of complications (i.e., bleeding), and facilitates nursing compared with the conventional radial approach. However, considering that the dRA is a distal site of the cRA, it may be smaller and characterized by various anatomical anomalies and branching. It is well established that determining the diameter of the dRA is necessary to minimize the risk of artery occlusion. Thus, the selection of an appropriate sheath size is crucial to safely perform catheter intervention via the dRA approach. Methods for the calculation of the vessel size,

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such as computed tomography or angiography, are invasive and involve the use of contrast medium and exposure of patients to radiation. In contrast, measuring the diameter of the vessel using ultrasound is an effective, economical, and noninvasive approach. Thus, it is currently the optimal method for the preoperative examination of patients. The objective of the present study was to measure and compare the diameters of the dRA and cRA using ultrasound prior to catheter intervention or angiography.

Methods

This was a retrospective observational study including patients who underwent coronary angiography or intervention at Aomori Kyoritsu Hospital, Aomori, Japan, between February 2018 and August 2018. All patients provided written informed consent. The equipment used for the ultrasound examination was the CX50 (Philips, Holland) with a linear 12–13 MHz transducer. The measuring point of the dRA was the proximal site of the branching princeps pollicis artery or the deep palmar arch in the anatomical snuff box at the level of the scaphoid and trapezium bones forming the floor. This triangle area surrounds the tendon of the extensor pollicis longus, the extensor pollicis brevis, and the abductor pollicis longus. Vessel diameter was defined as the distance from media to media. The measurement was performed 1 day prior to angiography or intervention. Patient characteristics, i.e., age, gender, height, weight, body mass index, smoking history, hypertension, diabetes, dyslipidemia, chronic kidney disease, past dRA and past cRA, were evaluated using a multivariate analysis.

Statistical analysis

Categorical variables are presented as numbers and percentages. Continuous variables are expressed as means and standard deviations. All statistical analyzes were performed using the EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), a graphic user interface for R (The R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 120 patients were analyzed between February 2018 and August 2018. Table 1 summarizes the characteristics of the patients. In male patients, the diameters of the cRA and dRA were 2.62 ± 0.60 mm and 2.04 ± 0.43 mm, respectively. In female patients, the diameters of the cRA and dRA were 2.44 ± 0.51 mm and 1.96 ± 0.44 mm, respectively (Table 2 and Fig. 1). The dRA was shown to be statistically significantly smaller than the cRA. However, 8 patients (6.7%) had a larger dRA than cRA. The mean diameter of the proximal radial arteries of patients who had undergone cannulation ($n = 63$; 52.5%) was 2.55 ± 0.59 mm. Of note, those of patients who had not undergone cannulation ($n = 57$; 48.5%) was 2.60 ± 0.56 mm. There was no statistically significant difference between these two groups ($p = 0.504$). The correlation index between the dRA and cRA was $r = 0.68$, indicating a strong correlation (Fig. 2). The cumulative frequency curves of the dRA and cRA for each gender are shown in Fig. 3. The ratio of dRA/cRA was 0.80 ± 0.14 in males, 0.81 ± 0.12 in females, and 0.80 ± 0.14 in all patients. The difference of cRA minus dRA was 0.56 ± 0.45 mm in males, 0.48 ± 0.34 mm in females, and 0.54 ± 0.42 mm in all patients. A multivariate analysis was performed to assess the role of patient characteristics as factors influencing vessel diameter. The results of this analysis did not link any of the examined factors to vessel diameter.

Table 1 Patient characteristics

Number of patients	120
Age (years)	71.1 ± 10.4
Male gender (%)	87.7
Height (cm)	159.9 ± 8.4
Weight (kg)	62.9 ± 11.6
BMI (kg/m^2)	24.4 ± 3.62
Hypertension (*n*, %)	86 (71.7%)
Diabetes (*n*, %)	76 (63.3%)
Dyslipidemia (*n*, %)	102 (85.0%)
Smoking (*n*, %)	73 (60.8%)
CKD (*n*, %)	52 (43.3%)
eGFR (mL/1.73/m^2)	66.41 ± 24.03
Virgin RA access (*n*, %)	56 (46.7%)
Previous cRA access (*n*, %)	63 (52.5%)
Previous dRA access (*n*, %)	1 (0.8%)

BMI body mass index, *CKD* chronic kidney disease defined as glomerular filtration rate of less than 60 mL/min/1.73 m^2, *eGFR* estimate glomerular filtration rate, *RA* radial artery, *cRA* conventional access point of the radial artery at the wrist, *dRA* distal access point of the radial artery

Table 2 The diameters of the conventional (cRA) and distal (dRA) access points of the radial artery

	cRA diameter	dRA diameter	*p* value
Total (mm)	2.57 ± 0.58	2.02 ± 0.44	< 0.001
Males (mm)	2.62 ± 0.43	2.04 ± 0.60	< 0.001
Females (mm)	2.44 ± 0.51	1.96 ± 0.44	< 0.001

cRA conventional access point of the radial artery, *dRA* distal access point of the radial artery

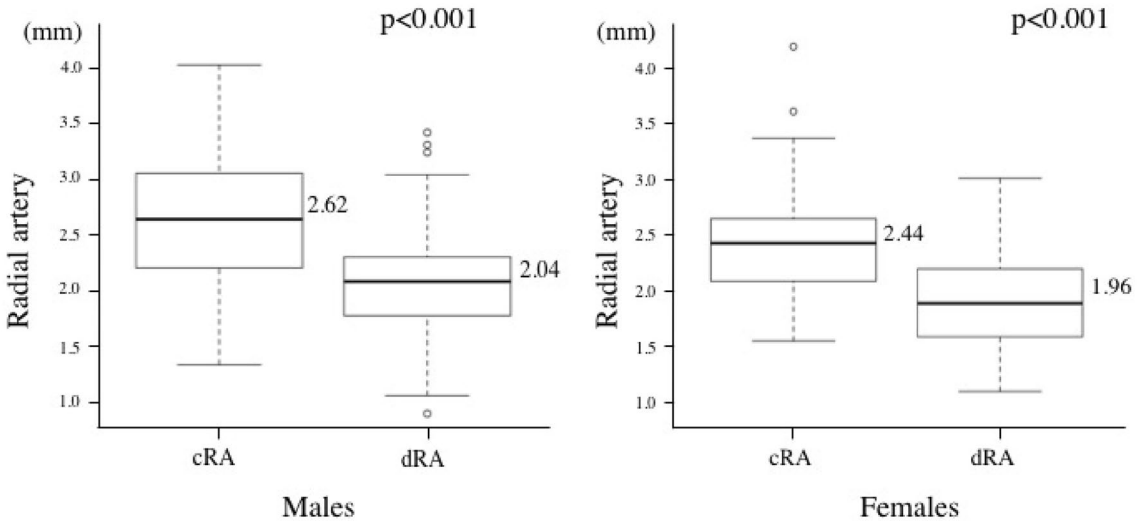

Fig. 1 The diameters of the distal access point of the radial artery and conventional access point of the radial artery at the wrist of male and female patients

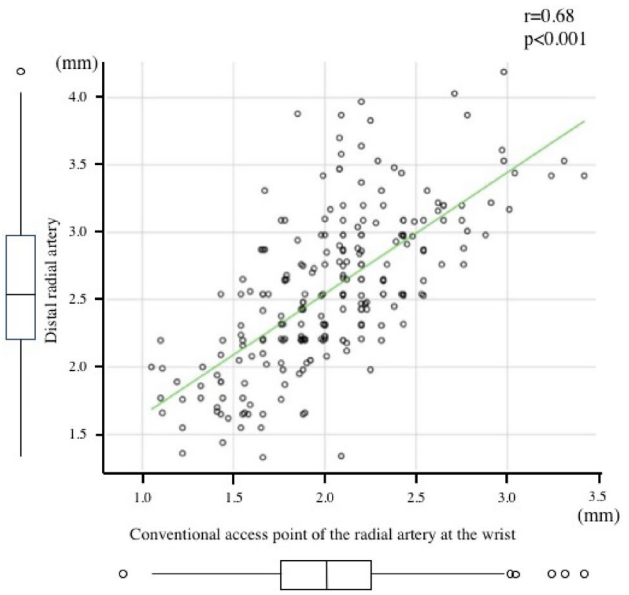

Fig. 2 The correlation index between the distal access point of the radial artery and conventional access point of the radial artery at the wrist

Discussion

The dRA approach is a novel procedure, and thus, data and experience related to this method are currently limited. Determining the size of the dRA prior to cannulation allows the selection of a sheath or guiding catheter of appropriate size to safely perform the procedure. This process is essential to minimize the risk of artery occlusion. Moreover, examination using ultrasound does not require the use of contrast medium and prevents exposure of patients to radiation. Therefore, the data presented in this article may be important for performing cannulation through the dRA approach in the future. Our data regarding the dRA and cRA indicated a strong correlation, and the difference between their diameters was approximately 0.5 mm. The multivariate analysis revealed that none of the examined parameters were correlated with the diameter of the dRA. However, the diameter of the dRA was larger than that of the cRA in 6.6% of patients. This observation may be attributed to anatomical variation or injury of the radial artery caused by previous cannulation. In all cases treated with the dRA approach, the physician should carefully select the most appropriate catheter or sheath size—at least one size smaller than that used in the cRA approach. Use of the GlideSheath Slender® (GSS) (Terumo, Japan), characterized by a thin wall and smaller outer diameter than any other sheath, is recommended in the dRA approach [6]. In general, an artery/sheath ratio> 1.0 indicates safe cannulation. Using the cumulative frequency curve of the dRA approach, a good indication for the insertion of the GSS 6Fr sheath (2.46 mm) was reported in merely 13% of male and 12% of female patients. Good indication for the insertion of the GSS 5 Fr sheath (2.13 mm) was reported in 37% of male and 30% of female patients. Insertion of the GSS 4 Fr sheath (1.96 mm) was indicated in 56% of male and 45% of female patients. Finally, insertion of the GSS 3 Fr sheath (1.58 mm) was indicated in 86% of male and 74% of female patients. According to these results, performing interventions through the dRA approach without measuring the diameter of the artery is associated with a high risk of dRA injury. Therefore, it is recommended

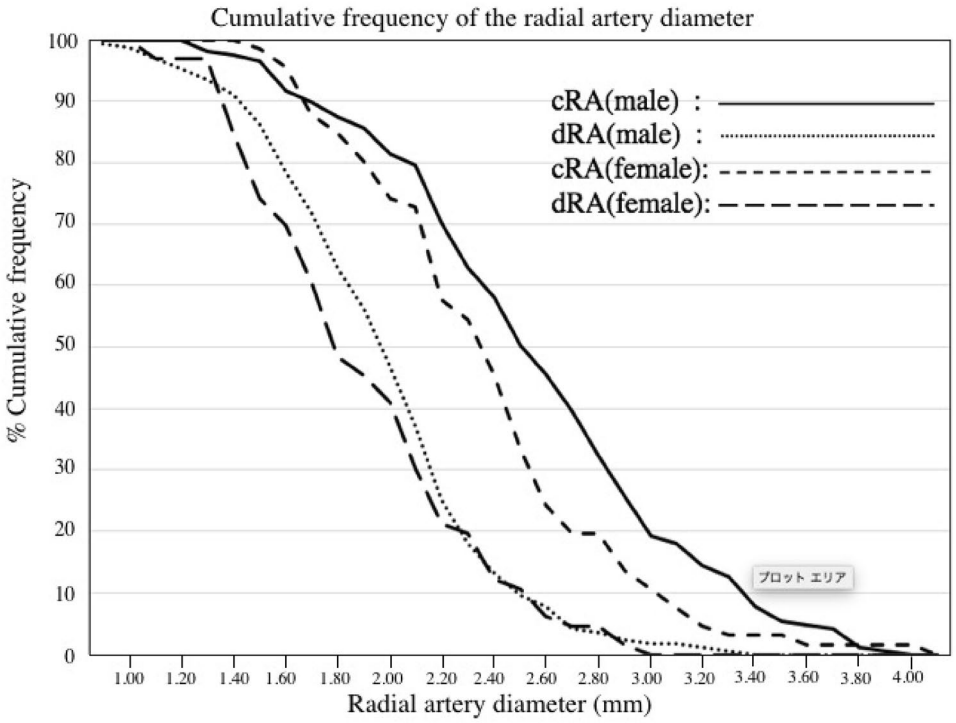

Fig. 3 Cumulative frequency of the radial artery diameter (distal access point of the radial artery and conventional access point of the radial artery at the wrist)

to measure the diameter of the dRA preoperatively in all patients planned to undergo distal TRI and select an appropriate sheath size or approach site according to the size of each vessel. The results of this study showed that cannulation in the absence of vessel diameter measurement were linked to a high risk of vessel injury. Considering that the dRA is smaller than the cRA, the lack of vessel size measurement will inevitably lead to an increased incidence of radial artery occlusion. The occurrence of functional disturbance as a result of the dRA approach (i.e., ischemia of the thumb or other fingers) is rare because of the presence of a double arterial arch in the palm. However, the occurrence of such complications may lead to irreversible consequences (e.g., local necrosis). In addition to the measurement of the diameter of the access artery, use of ultrasound-guided puncture may be useful. Studies have reported that ultrasound-guided puncture is superior to puncture with pulsation only through the radial or femoral approaches [7, 8]. The limitations of this study should be acknowledged. First, this study was a retrospective analysis of the diameters of the dRA and cRA, and the interpretation of the findings was based on the hypothesis that an artery/sheath ratio < 1.0 indicated a high risk of vessel injury. Second, this study involved a single center and a small sample size. Finally, the examined population residing in Aomori, Japan is characterized by short stature, high risk of coronary artery disease, and the shortest life expectancy in the country. Therefore, randomized prospective studies are warranted to investigate the dRA approach involving measurement of the diameter of the artery prior to intervention.

Conclusion

The results of this study showed that the size and anatomy of the dRA varied considerably. Thus, it is difficult to predict the actual diameter of the artery. Determining the diameter of the dRA is necessary to minimize the risk of artery occlusion. Customized selection of the size of the sheath and site of intervention is essential for each patient to safely perform ultrasound examination prior to cannulation.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study protocol was reviewed and approved by the ethics committee of Aomori Kyoritsu Hospital.

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