INTERVENTIONAL RADIOLOGY
Official journal of the Japanese Society of Interventional Radiology and Asia Pacific Society of Cardiovascular and Interventional Radiology

TECHNICAL NOTE

Feasibility and Safety of the Distal Transradial Access for Noncardiac Intervention

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Abstract:
Purpose: Distal transradial access through the anatomical snuffbox has been highlighted in recent research because it provides extremely low invasiveness. It has demonstrated its feasibility and safety for cardiac intervention. However, its characteristics for noncardiac intervention are not well known. This report aims to demonstrate the feasibility and safety of noncardiac intervention with distal transradial access, with identification of practical devices for procedures.
Material and Methods: This retrospective study was conducted from May 2021 to December 2021 with consecutive patients who underwent distal transradial access for noncardiac intervention. This study analyzed patient physical information, procedural details, technical success rates, and distal transradial access-associated complications.
Results: Nine patients (7 females, 2 males) aged 48-69 years (median: 57) were enrolled in this study. This study assessed 11 noncardiac procedures, such as transarterial infusion chemotherapy for head and neck malignancies (n = 4), embolization of visceral artery aneurysm (n = 2), embolization of renal angiomyolipoma (n = 2), percutaneous transluminal renal angioplasty (n = 1), bronchial artery embolization (n = 1), and diagnostic angiography (n = 1). The introducer sheath size was 4-6 French. Catheters respectively having nine tip shapes were used. Reverse curve catheters were used only in two cervical procedures. The technical success rate was 91% (10/11). Of the 11 procedures, only 1 (bronchial artery embolization) required conversion to transfemoral access. There was no complication associated with distal transradial access. Ultrasound evaluation after treatments revealed patent radial arteries in all patients.
Conclusions: Results revealed that distal transradial access is feasible with commercially available catheters and is safe for various noncardiac interventions.

Keywords:
distal transradial access, dTRA, anatomical snuffbox, noncardiac intervention

Interventional Radiology 2024; 9(3): 186-191
https://doi.org/10.22575/interventionalradiology.2023-0024
https://ir-journal.jp/

Introduction

Distal transradial access (dTRA) has gained attention recently for cardiac interventions. This minimally invasive arterial approach method reaches from the distal radial artery in the anatomical snuffbox (**Fig. 1**). For the patient, dTRA presents several benefits, such as earlier postprocedural ambulation, short hemostasis time, less pain, and lower incidence of complications at the puncture site [1, 2]. Additionally, the operator can perform interventional procedures with dTRA in the same patient position with the same angiography suite settings as those used for transfemoral access (TA) (**Fig. 2**). Therefore, an operator familiar with TA can also benefit from dTRA, a benefit that is not provided by transradial access (TRA). Due to these benefits, dTRA is also increasingly applied as a minimally invasive approach for noncardiac interventions. Nevertheless, only a few reports have described the efficacy of dTRA in noncardiac interventions [3-7]. Its feasibility and safety remain unclear. Few descriptions of the devices are suitable for noncardiac

Corresponding author: Takeshi Wada, rbkyw444@gmail.com
Received: May 25, 2023, Accepted: December 11, 2023, Advance Publication by J-STAGE: July 24, 2024

interventions with dTRA. In general, the distance from the access site to the target artery is greater in dTRA interventions than in TA/TRA interventions. In addition, the angle at which the target artery diverges from the aorta differs from that in TA interventions, making selection of angiographic catheter tip shapes particularly important.

This study was conducted to elucidate the feasibility and safety of noncardiac interventions with dTRA and to identify practical devices for the procedure.

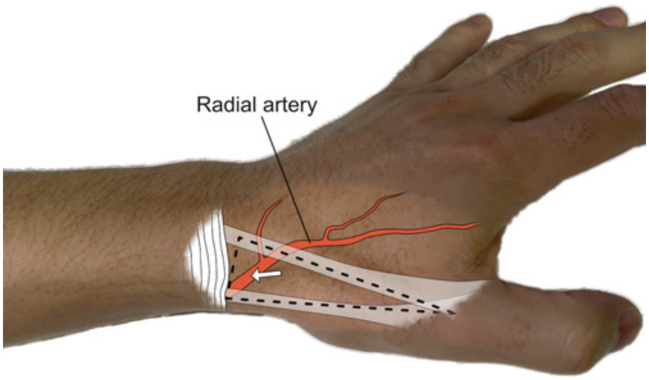

Figure 1.
Anatomy of the distal radial artery. The typical puncture site for the distal transradial access (arrow) is from the distal radial artery running within the snuffbox (dotted triangle). The catheterization site in the distal transradial access is more distal than in the classical transradial access.

Material and Methods

Study design

This retrospective study included consecutive patients who underwent noncardiac intervention with dTRA during May 2021 to December 2021. This study was approved by our institutional review board. Informed consent was waived due to the retrospective nature of this study.

Preprocedural assessment

The presence of functioning dual circulation to the hand was confirmed using the Barbeau test and modified Allen's test [8]. If the modified Allen's test was positive and the Barbeau test showed type A, B, or C, then the patient was regarded as having functional collateral blood flow from the ulnar artery.

Ultrasound (US) estimation of the radial artery was assessed along its entire course for the size of the radial artery, variant anatomy, and presence of stenosis or obstruction. Distal radial artery measurements were obtained in the anatomical snuffbox on the scaphoid or trapezium.

Procedural details

The position of the patient in the angiography suite is the same as that used for TA intervention. The left arm is on the lower abdomen and pelvis. After local anesthesia, the left distal radial artery is accessed using 22-Gauge plastic needles under US guidance. A 0.018-in. wire is then advanced into the radial artery. A hydrophilic sheath is inserted via the Seldinger technique. We used Prelude IDEAL (Merit Medical Japan, Tokyo, Japan), Glidesheath Slender (Terumo Corp., Tokyo, Japan), and other thin-walled guiding sheaths

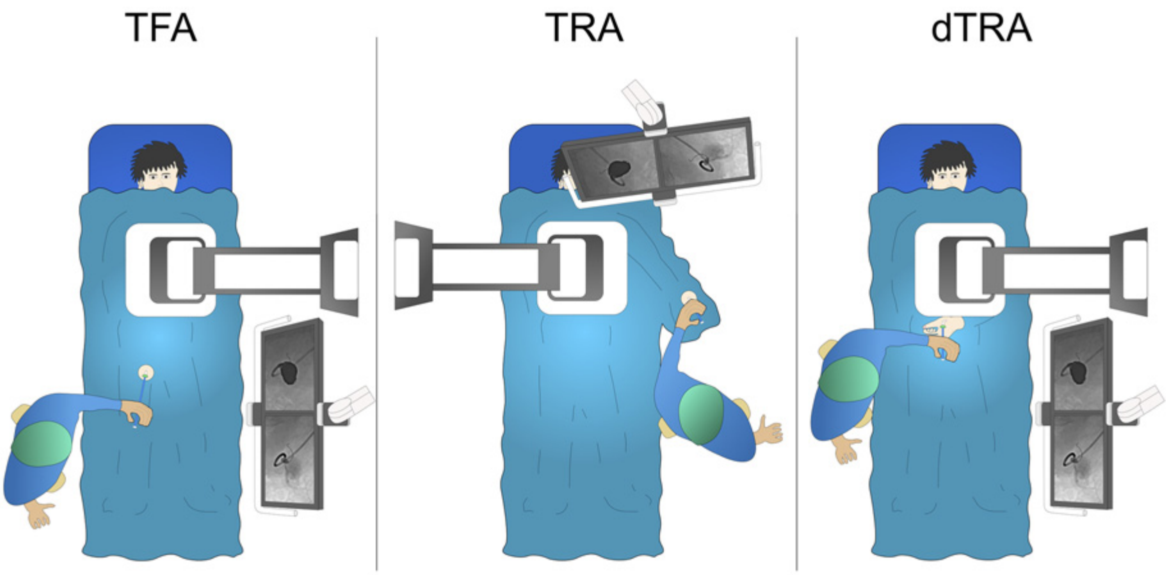

Figure 2.
Patient positioning and angiographic suite setting for each approach. The distal transradial access with the left hand on the lower abdomen allows an almost identical setting to that used for transfemoral access. The same positioning is difficult with transradial access due to the difficulty of forearm pronation during the procedure.
TA, transfemoral access; TRA, transradial access; dTRA, distal transradial access

Table 1. Patient Physical Information.

Patient	Age	Sex	Etiology
1	59	Female	Splenic artery aneurysm
2	63	Female	Stenosis of renal artery stent
3	50	Female	Renal artery aneurysm
4	62	Male	Renal angiomyolipoma
5	57	Female	Renal angiomyolipoma
6	48	Male	Recurrent pharyngeal cancer
7	57	Female	Maxillary sinus cancer
8	69	Female	Hemoptysis
9	61	Female	Renal artery stenosis due to fibromuscular dysplasia

Table 2. Relation of the Distal Radial Artery Diameter to the System Size.

Patient	Laterality	Size of distal radial artery (mm)	Vascular access equipment	Outer diameter of system (mm)
1	Left	1.9	5-French Glidesheath Slender	2.14
2	Left	1.9	5-French Glidesheath Slender	2.14
3	Left	2.1	6-French Prelude IDeal	2.44
4	Left	2.3	5-French Prelude IDeal	2.13
5	Left	2.6	4-French Prelude IDeal	1.78
6	Left	2.4	4-French Prelude IDeal	1.78
7	Left	2.2	4-French Prelude IDeal	1.78
8	Left	1.7	4-French Prelude IDeal	1.78
9	Left	2.1	Parent Plus® 45	2.17

Note: Glidesheath Slender sheaths (Terumo Corp., Tokyo, Japan), Prelude IDeal sheaths (Merit Medical Japan, Tokyo, Japan), Parent Plus® 45 (Medikit Co. Ltd., Tokyo, Japan)

as radial artery sheaths in all cases. These thin-walled sheaths provide 5-French lumen while maintaining an outer diameter that matches the diameter of a 4-French sheath. Tip shapes of the catheter were determined based on the branching angle of the target vessel relative to the direction of catheter advancement, the diameter of the parent artery, and the support necessary for the treatment.

After sheath insertion, 50 IU/kg heparin, 2.5 mg verapamil, and 250 μg of nitroglycerin hemodiluted by aspirated blood were injected via the sheath to prevent arterial spasm and to reduce radial artery occlusion (RAO) [8]. Furthermore, in cases of visceral aneurysms and angioplasty, intraprocedural anticoagulation with heparin is used. At the end of each procedure, we perform digital subtraction angiography of the forearm to hand to evaluate the palmar arterial arch, blood flow to the fingers, and vascular injury.

Following catheter removal, hemostasis is achieved using a balloon compression device designed explicitly for dTRA (Sync Distal; Merit Medical Japan, Tokyo, Japan). Hemostasis is then achieved according to the institutional protocol: After the balloon is first inflated with 10 ml of air, it is then gradually deflated. When a small amount of bleeding is observed at the puncture site, 1-2 ml of air is added. After 1 h, the balloon inflation volume is reduced by half, and then compression is continued for another hour. Therefore, the total hemostasis time is 2 h.

Postprocedural assessment

On the day following the procedure, each patient had a physical examination and US follow-up of the forearm to the distal radial artery. The interventional radiologist who performed the procedure assessed postprocedural complications: hematoma, pseudoaneurysm, dissection, RAO, and hand and arm symptoms.

We analyzed patient physical information (age, gender, and etiologies), the distal radial artery size, and procedural details such as the procedure type, system size, targeted artery, catheter tip shape, technical success rate, complications associated with dTRA, and patency of postprocedural radial artery. Technical success was defined as completion of the noncardiac intervention using dTRA alone with no change to the TA.

Results

For the nine enrolled patients (seven females, two males) aged 48-69 years (median: 57), **Table 1** presents relevant physical information. The median size of the distal radial artery was 2.2 mm (1.7 mm-2.6 mm). Five patients had inserted sheaths that were larger than the diameter of their distal radial arteries. **Table 2** presents relations between the size of each patient's distal radial artery and the introducer sheath outer diameter. Two patients (patients 6 and 7) had initial treatments with TFA. They repeated the other two sessions with dTRA for the same access site with an interval of 1 week or 2 weeks. The last two sessions were included in these analyses. Finally, 11 noncardiac procedures were analyzed (**Table 3** and **Fig. 3**). Ten (91%) out of 11 proce-

Table 3. Procedural Details.

Patient	Procedure	Targeted artery	Catheter tip shapes	Technical success	Complication
1	TAE	SpA	YASHIRO Radial	Yes	None
2	Diagnostic angiography	Transplant RA	MP	Yes	None
3	TAE	Right RA	R.A.V.I. MG1	Yes	None
4	TAE	Right RA	R.A.V.I. MG1	Yes	None
5	TAE	Right RA	MP	Yes	None
6	TAI	Left ACA	L-curve	Yes	None
	TAI	Left ACA	L-curve	Yes	None
7	TAI	Left IMA	SIM	Yes	None
	TAI	Left IMA	SIM	Yes	None
8	BAE	Bilateral BA	JR, JL, Jacky, JB-2	No	None
9	PTRA	Right RA	MP	Yes	None

TAE, transcatheter artery embolization; SpA, splenic artery; RA, renal artery; MP, multipurpose; R.A.V.I., radial access for visceral intervention; TAI, transarterial infusion therapy; ACA, ascending cervical artery; IMA, maxillary artery; SIM, Simmons; BAE, bronchial artery embolization; BA, bronchial artery; JR, Judkins Right; JL, Judkins Left; JB-2, Bentson–Hanafee–Wilson II; PTRA, percutaneous transluminal renal angioplasty

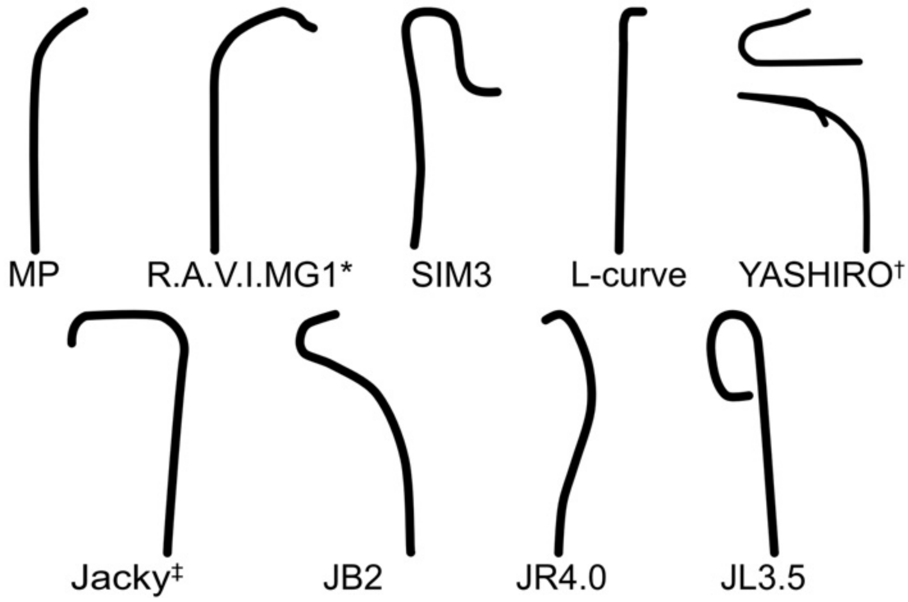

Figure 3.

Catheter tip shapes used for noncardiac interventional procedures.

MP, multipurpose; SIM3, Simmons 3; JB-2, Bentson–Hanafee–Wilson II; JR4.0, Judkins Right 4.0; JL3.5, Judkins Left 3.5

* R.A.V.I. MG1: Radifocus™ Glidecath™ R.A.V.I. MG1 (Glidecath™ II in Japan, Terumo Corp., Tokyo, Japan)

† YASHIRO: Radifocus™ Glidecath™ YASHIRO Radial (Glidecath™ II in Japan, Terumo Corp., Tokyo, Japan)

‡ Jacky: Radifocus™ Optitorque™ Jacky Radial (Heartcath™ in Japan, Terumo Corp., Tokyo, Japan).

dures achieved technical success. Reverse curve catheters (such as Simmons, Shepherd hook, Mikaelson, and various Loop shapes), commonly used with TFA, were used in only two procedures: cannulating the left common carotid artery (**Table 3** and **Fig. 3**). The other successful procedures were achieved with preshaped, nonreverse curve catheters. Among six procedures performed in the abdominopelvic region, three used a catheter for radial access (Yashiro Radial [Glidecath™ II in Japan; Terumo Corp., Tokyo, Japan] and R.AV.I. MG1 [Glidecath™ II in Japan; Terumo Corp., Tokyo, Japan]). Of the remaining three abdominopelvic procedures, one procedure (patient 2), which involved insertion into the transplanted renal artery anastomosed to the iliac artery, required an exceptionally long catheter: a 145 cm multipurpose-shaped catheter. For patient 5, we first attempted to select the right renal artery using a catheter for radial access. However, because the catheter was not stable, we substituted the catheter to a multipurpose-shaped catheter. For patient 9, a multipurpose-shaped guiding catheter with the most extended effective length that is commercially available was used to deliver a stent to the renal artery. For patient 6, the ascending carotid artery was bifurcated at a vertical angle from the subclavian artery. An L-curve-shaped catheter was then used to adapt to the angle of branching. Only 1 of the 11 procedures, BAE, required conversion to TA to complete the treatment despite using various pre-shaped catheters via dTRA. There was no complication related to the dTRA. No patient had any hand or arm symptom. The radial artery was patent in all cases, including those of the two patients with repeated procedures.

Discussion

This study was conducted to assess the feasibility and safety of noncardiac intervention with dTRA and to identify practically useful devices for the procedure. The findings obtained from this study report that several noncardiac interventions can be performed safely using various commercially available devices.

Earlier reports of studies examining the feasibility of noncardiac intervention with dTRA have described technical success rates of 97.6-100% [3-7]. The technical success rate found in this study was as high as 91%, a figure resembling those of earlier reports. One possible reason for the high technical success rate in dTRA might be that the diverging angles of the target artery from the aorta are inverse to those of TA. Park et al. reported a high technical success rate (97.6%) for noncardiac interventions without reverse curve catheters, the most frequent catheter used in TA [7]. For this study, the reverse curve catheters were employed in only three procedures, with results similar to those of the study described above.

The reversed curve catheters are regarded as beneficial for the selective cannulation of vessels, particularly those diverging in an inverted orientation from the access site. However, inserting the catheter deeper than into the inverted section can pose a challenge. Moreover, inserting nonreverse curve catheters into sharply diverging vessels can also be challenging. Nonetheless, deep insertion becomes easier than reverse curve catheters once selective and stable insertion is accomplished. Unlike TA, the angle of the abdominal arteries' divergence from the access point is usually obtuse for dTRA. Therefore, in dTRA, the selection and deep insertion of abdominal arteries can be executed without resorting to the reversed curve catheter. This anatomical feature and the characteristics of nonreverse catheters might have offered the necessary backup for achieving the treatment, potentially influencing the high technical success rate.

BAE, which was not completed by dTRA alone in this study, had a discrepancy from the only report challenging BAE with dTRA [7], showing technical success in 7/7 (100%) cases. In that study, a Davis catheter (Jung Sung Medical Co. Ltd., Seongnam, South Korea) and a Headhunter catheter (Jung Sung Medical Co. Ltd., Seongnam, South Korea) were used with good technical success. These catheters might be suitable choices for BAE. However, anatomic variations were found among our cases: The right bronchial artery originated from a higher descending aorta than usual, resulting in a smaller than usual distance between the aortic arch and the bronchial artery's orifice. It was found that the left bronchial artery was narrow and tortuous. Consequently, in addition to using those catheters, a catheter with a three-dimensional tip that was shaped individually to fit the patient's bronchial artery might have been effective.

For this study, two patients with head and neck malignancies were treated safely for two sessions each. In one of these patients, the maxillary artery was the target vessel. The reverse curve (Simmons) catheter allowed stable cannulation of the left common carotid artery diverging in an inverted orientation from the access site. To the best of our knowledge, this study is the first to demonstrate transarterial infusion therapy for head and neck malignancies with dTRA. Because dTRA is less stressful for the patient and this procedure usually requires multiple sessions, it might be a preferred access option.

However, forearm RAO is a complication that should not be allowed because surgery for head and neck malignancies is performed occasionally with a radial forearm flap for reconstruction. The incidence of forearm RAO in TRA has been reported as 1-10% [9], which is not negligible for patients with a chance of having reconstructive surgery using a radial forearm flap.

In fact, the forearm RAO rate after dTRA has been reported as extremely low (0.7%) and significantly lower than that of TRA (8.4%) [10]. Moreover, our study had no case of RAO from the forearm to the anatomical snuffbox, supporting the findings presented in that earlier report. The distal radial artery branches off the superficial palmar arch before entering the anatomical snuffbox, which is thought to preserve blood flow of the forearm radial artery even if occlusion occurs in the distal radial artery. Consequently, the possibility of dTRA affecting the availability of a radial forearm flap is extremely low: dTRA is also an effective access site for the endovascular treatment of head and neck malignancies.

For this study, all procedures were performed safely without complications. The complication incidence in dTRA has been reported as low (0%-9.8%) [3-7]. Our results are consistent with those presented in earlier reports. The most frequent complication is hematoma at the puncture site, but most of the complications are minor hematomas. They rarely engender clinical problems [3-7]. Mizuguchi et al. reported that a minor subcutaneous hematoma at the puncture site was observed in 4.4% of patients and there was no hematoma extending to the forearm [1]. Rigatelli et al. reported that there was no significant difference between dTRA and TRA in the frequency of puncture site hematoma [2].

The anatomical snuffbox is a triangular space bounded by the styloid process of the radius (proximal border), the extensor pollicis longus tendon (ulnar border), and the extensor pollicis brevis tendon and abductor pollicis longus tendon (radial border). The scaphoid and trapezium form the floor of the anatomical snuffbox. The distal radial artery travels superficially on these bones in this narrow space. Consequently, during hemostasis, the distal radial artery is held in place by tendons. It is tightly compressed between the hemostatic device and these bones, making hemostasis easy and confident. The lower incidence of severe hemorrhagic complications is an important benefit of dTRA.

The superficial branch of the radial nerve, a sensory nerve, runs near the anatomical snuffbox. Therefore, dTRA entails a risk of radial nerve injury. Mizuguchi et al. [1] reported the incidence of radial nerve injury as 0.9%. Most of these patients had mild numbness that improved without intervention. Long-term symptoms were extremely rare. Although the frequency of radial nerve injury is low, it is a possible complication of dTRA. Informed consent to dTRA is absolutely necessary.

This study has several limitations. First, this study's retrospective nature and small sample size might have biased the results. Furthermore, this study did not include all noncardiac interventions. Therefore, it cannot be ascertained whether dTRA applies to all noncardiac interventions. Finally, US evaluation of the radial artery was performed only on the following day. For this reason, this study did not evaluate mid- to long-term puncture site complications.

In conclusion, our findings suggest that dTRA is feasible and provides safe access for several noncardiac interventions. In dTRA, nonreverse curve catheters for abdominal arteries, reverse curve catheters for cervical arteries, and individually shaped catheters to fit the patient's anatomy for thoracic arteries might be practical. Not only is dTRA less invasive for patients, it should be adopted widely for noncardiac interventions. Further studies are necessary in order to confirm the feasibility of other procedures that were not examined in this study.

This study has been presented at JSIR/APSCVIR2022.

Acknowledgement: No grants, disclosures, or other assistance were received.

Conflict of Interest: None

Author Contributions: All authors meet the International Committee of Medical Journal Editors criteria for authorship and take responsibility for the content of the article.

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