Ulnar Access for Catheterization and Intervention

When and how radial operators should consider transulnar access as an alternative to transfemoral access.

BY SAFI U. KHAN, MD; MICHAEL DEPERSIS, DO; AND EDO KALUSKI, MD, FACC, FESC, FSCAI

Transradial access (TRA) for coronary angiography and interventional procedures has grown in popularity due to enhanced patient safety (ie, reduced major vascular and bleeding complications), early patient ambulation, and reduced hospital stay when compared with femoral artery access.[1-3] However, TRA has its limitations, including asymptomatic radial artery occlusion (in 4%–10% of cases) and considerable access crossover rates (in 5%–8% of cases).[4,5] Furthermore, 5% to 10% of candidates are not suitable for TRA at all.[6] Transulnar access (TUA) can serve as an alternative approach whenever the risk of TRA failure or complications is expected to be high due to small diameter, radial stenosis calcification, tortuosity, or other known anatomic issues.[6,7]

This article discusses TUA for coronary procedures and appraises the scientific evidence regarding feasibility and safety of TUA along with a discussion on anatomic and technical aspects of this procedure.

ANATOMIC ASPECTS

Course

The ulnar artery is the larger of the two branches of the brachial artery; typically originating 5 to 7 cm distal to the elbow, and, it progresses along the medial portion of the forearm and runs distally adjacent to the ulnar nerve. A line joining the medial epicondyle of the humerus to the lateral side of the pisiform bone roughly reflects the course of the ulnar artery in the forearm. The ulnar artery is covered by the flexor carpi ulnaris and flexor digitorum sublimis muscles in the middle third of the forearm and lies lateral to the tendon of flexor carpi ulnaris muscle in the distal third of the forearm. After crossing the transverse carpal ligament and pisiform bone, the ulnar artery divides into two branches that begin the formation of the superficial and deep palmar arches (Figure 1). The superficial palmar arch (complete in 40%–80% of cases) is fed by the ulnar artery (medially) and superficial branch of the radial artery (laterally). The deep palmar arch (complete in 99% of cases) is formed by the radial artery (laterally) and the deep palmar branch of the ulnar artery (medially). The ulnar artery is best palpated on the anteromedial aspect of the proximal wrist fold when the wrist is hyperextended. Most anatomy reports suggest that the ulnar artery has a similar diameter and fewer α-1 receptors than the radial artery.

Modified Allen Test

Some physicians challenge the necessity of a routine modified Allen test before TRA,[8] whereas others imply

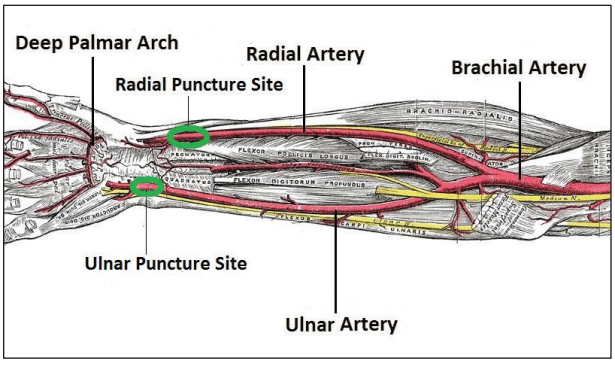

Figure 1. Course of ulnar artery in forearm and palmar blood flow with puncture sites.

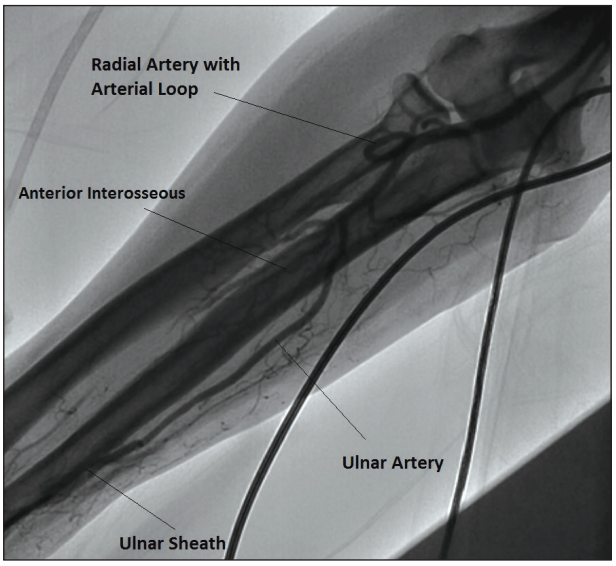

Figure 2. Angiogram of forearm blood supply with radial artery loop.

that TUA is both feasible and safe even in the presence of a type D Barbeau test result (ie, the absence of any pulse oximetry signal upon compression of the ipsilateral ulnar artery), the absence of a palpable ipsilateral radial artery, or a known occluded or removed radial artery (for arterial conduit purpose).[9] We suggest that alternative access (contralateral wrist or femoral artery) is not mandated even when a class D Barbeau test result is encountered. In our view, a modified Allen test, which is done by applying occlusive pressures to radial and ulnar arteries while the hand is closed tightly to obstruct blood flow to the hand, is an important tool to assess the baseline and postprocedural brachial and palmar blood flow, and may enhance the pre- and postprocedural assessment. Furthermore, we believe that a type D Barbeau test result should raise the consideration of an alternative arm or access site and create awareness among the interventional team that the patient's anatomy is suboptimal.

Similar to TRA, the shortest and smallest-diameter sheath should be used to minimize the risk of arterial injury and patient discomfort. Proximal ulnar artery thrombosis can potentially affect the anterior interosseous artery (which stems from the proximal ulnar artery), which is the predominant collateral to the lateral aspect of the wrist in case of radial artery occlusion (Figure 2). Therefore, if the radial artery is known to be occluded, the presence of collateral circulation to the lateral aspect of the wrist should be routinely assessed by injecting contrast into the accessed ipsilateral ulnar artery.

TECHNICAL ASPECTS

After obtaining informed patient consent, a Barbeau test (using pulse oximetry) should be performed to evaluate the collateral flow in the hand. Optimal TUA begins with moderate conscious sedation to mitigate arterial spasm. Arm and forearm comfort and support are required while the palm is secured in a supinated hyperextended position similar to the TRA procedure. Contrary to TRA failure, which is predominantly due to spasm, transulnar cannulation failure results from an inability to palpate or access the ulnar artery or difficulty in initially advancing the wire, despite adequate blood flow. Hyperextension of the wrist is crucial for a successful procedure because it stabilizes the wrist and enhances the ability to palpate the ulnar artery at the level of the wrist fold.

Side Selection

Right side access is preferred over left side access in the majority of cases, mainly due to operator convenience, reduced radiation exposure, or when percutaneous coronary intervention (PCI) of the left coronary artery is desired. The left ulnar artery is typically the preferred access site in patients with known prior left internal mammary artery bypass surgery or planned PCI of heavily calcified, tortuous, or chronically occluded right coronary arteries. This practice is based on radial experience suggesting that PCI to the right coronary artery will receive more support using the left wrist approach and vice versa for the PCI of the left coronary artery.[10]

Procedure

The ulnar artery is punctured using a 21-gauge needle (aiming 60°–75° cephalad) in the proximal wrist fold using either the modified Seldinger technique or Seldinger technique proximal to the pisiform bone. Like TRA, there is no evidence to support these two approaches, however, we prefer an anterior wall stick approach for all TUA procedures. This decision is based on the fact that the ulnar artery is relatively deep and less compressible than the radial artery, and to avoid an unintentional trauma to ulnar nerve, because the ulnar artery lies in close proximity of the nerve.

After cannulation of the ulnar artery, a soft-tip, 0.018-inch guidewire, preferably with a mildly angled tip, is introduced, over which a sheath with dilator is advanced (Figure 2). A 5- or 6-F sheath is suitable for PCI, and a 4- or 5-F sheath is preferred for diagnostic angiography. The sheath can be partially inserted into the ulnar artery especially when resistance is encoun-

TABLE 1. SUMMARY OF PUBLISHED LITERATURE DEMONSTRATING PROCEDURAL SUCCESS AND COMPLICATION RATES

Author	Patients (N)	Procedures (n)	Sheath Size (F)	Success Rate (%)	Crossover Rate (%)	Complications, % of Cases
Hahalis et al[11]	462	462	5–7	67.7	32.3	Large hematoma, 1.9%; arterial occlusion, 6% at 60 days
Agostoni et al[12]	42	36	5–7	86	14	None
Mangin et al[13]	117	122	4–7	85.2	14.8	Local hematoma, 4%. large hematoma, 0.8%; pseudoaneurysm, 0.8%
Aptecar et al[14]	172	173	4–6	91	9	Local hematoma, 4%; ulnar occlusion, 0.6%; pseudoaneurysm, 0.6%
Rath et al[15]	100	100	5–6	95	5	Local hematoma, 1%; artery perforation, 1%; transient paraesthesia, 1%
Aptecar et al[16]	216	216	4–5	93.1	6.9	Large hematoma, 0.4%; local hematoma, 2.3%; arteriovenous fistula, 0.4%; transient paraesthesia, 1.4%; ulnar occlusion, 5.7%
Gokhroo et al[17]	410	410	5–6	97.8	2.2	Ulnar occlusion, < 1%; minor bleed, 2.2%
Li et al[18]	120	120	5–7	98.3	1.7	Local hematoma, 5.8%; ulnar occlusion, 1.7%
Liu et al[19]	317	317	6	92.7	–	Ulnar occlusion, 6.3%; access hematoma, 2.6%; forearm hematoma, 1.6%
Andrade et al[20]	387	410	5-7	98.5	1.5	Local hematoma, 2.8%; large hematoma, 0.5%; ulnar occlusion, 0.5%
Chugh et al[21]	266	266	4-8	98.7	1.3	None
Kedev et al[22]	474	462	5-8	97	3	Large hematoma, 1.4%; minor hematoma, 8%; spasm, < 1%
Geng et al[23]	271	271	4–6	95.1	4.9	Arterial occlusion, 1.1%; hematoma, 7.3%; motor weakness, 0.4%
Vassilev et al[24]	92	59	–	64	36	None
Knebel et al[25]	28	26	5–6	93	7	None
Kwan et al[26]	17	17	5–7	100	0	None
Deshmukh et al[27]	81	81	5–7	94	6	Large hematoma, 2.1%

tered. Sheath fixation by either suturing or fixation with Tegaderm (3M Medical) can limit the sheath movement. Routine vasospasm should be mitigated with intra-arterial administration of vasodilators such as verapamil (2.5–5 mg) or nicardipine (250–500 µg), with optional nitroglycerin (200–600 µg). Ulnar artery thrombosis can be minimized with the use of anticoagulation (40–70 U/kg unfractionated heparin).

Fluoroscopic guidance can be avoided for initial advancement (up to 50 cm) of the 0.035-inch J-shaped wire across the ulnar artery and brachial artery. Fluoroscopy should be used to guide advancement of an angled-tip, 0.035-inch glidewire or a 0.014-inch hydrophilic wire in cases of resistance or extreme tortuosity. Selective angiography should be considered for any case with an inability to easily advance the wire. Catheter selection for coronary angiography and intervention is identical to TRA. Compared with left TUA, smaller-curve Judkins left catheters (typically Judkins left 3.5) are required to intubate the left coronary ostium through the right TUA. A long (ie, 240 cm) J-wire is needed for catheter exchanges, and each catheter exchange requires flushing the ulnar sheath with heparinized saline. Finally, the ulnar sheath should be removed, and radial arteriotomy compression devices should be applied to the ulnar artery according to patent hemostasis technique.

OUTCOMES

There is no unique treatment strategy for TUA procedures other than reported in this review, and the standard informed consent, as used for TRA, should be used.

Success Rate

In a meta-analysis of five randomized clinical trials, both the TRA and TUA groups had comparable major adverse cardiovascular events (a composite of myocardial infarction, target vessel revascularization, stroke, and death; relative risk [RR], 0.86; 95% confidence interval [CI]; $P = .54$; I2 = 0%), access complication rates (RR, 0.92; 95% CI, 0.67–1.27; $P = .64$; I2 = 57%), and bleeding events (RR, 0.87; 95% CI, 0.45–1.71; $P = .69$; I2 = 62%). However, TUA had twice the crossover rate compared with TRA (RR, 2.31; 95% CI, 1.07–4.98; $P = .003$; I2 = 75%).[28]

Ipsilateral Crossover From the Radial Artery to the Ulnar Artery

Accumulating evidence suggests that in cases of TRA failure, switching to TUA is safe rather than preparing the contralateral femoral artery of the wrist.[7,9] In the AURA-of-ARTEMIS study, ipsilateral switching in 134 TRA failures did not cause hand ischemia.[11] Agostoni et al showed this technique was safe in 86% patients, and de Andrade et al showed that seven of 81 patients who underwent TUA procedures had hand ischemia due to absent radial artery or radial artery spasm.[12,29] This heterogeneity most likely reflects considerable differences in patient selection, operator experience, imaging guidance, and equipment used.

Complications

The combined complication rate of TUA does not exceed 10%, and most complications are mild and similar to those encountered with TRA. Potential complications include ulnar artery occlusion (mostly asymptomatic), perforation, bleeding, hematomas, arterial spasm, and rarely pseudoaneurysms or arteriovenous fistulas. Ulnar nerve injury or irritation leading to sensory and motor dysfunction may also occur, although it is exceedingly rare and transient (Table 1).

CONCLUSIONS

TUA is a patient-friendly strategy that minimizes transfemoral access and results in lower complication rates, decreased patient discomfort, and allows for early ambulation. TUA requires a short learning curve for TRA operators because similar procedural techniques and devices are used, and both approaches pose similar challenges and complications (mostly arterial spasm occlusion and minor access site bleeding). ■

1. Campeau L. Percutaneous radial artery approach for coronary angiography. Cathet Cardiovasc Diagn. 1989;16:3-7.
2. Kiemeneij F, Laarman GJ. Percutaneous transradial artery approach for coronary stent implantation. Cathet Cardiovasc Diagn. 1993;30:173-178.
3. Rao SV, Cohen MG, Kandzari DE, et al. The transradial approach to percutaneous coronary intervention: historical perspective, current concepts, and future directions. J Am Coll Cardiol. 2010;55:2187-2195.
4. Agostoni P, Biondi-Zoccai GG, de Benedictis ML, et al. Radial versus femoral approach for percutaneous coronary diagnostic and interventional procedures; systematic overview and meta-analysis of randomized trials. J Am Coll Cardiol. 2004;44:349-356.
5. Jolly SS, Yusuf S, Cairns J, et al. Radial versus femoral access for coronary angiography and intervention in patients with acute coronary syndromes (RIVAL): a randomised, parallel group, multicentre trial. Lancet. 2011;377:1409-1420.
6. Sattur S, Singh M, Kaluski E. Transulnar access for coronary angiography and percutaneous coronary intervention. J Invasive Cardiol. 2014;26:404-408.
7. Hahalis G, Deftereos S, Bertrand OF. Ulnar artery: the Ulysses ultimate resort for coronary procedures. Hellenic J Cardiol. 2016;57:238-246.
8. de Andrade PB, Tebet M, Andrade M, et al. Performance of coronary procedures through the transulnar access without assessment of the integrity of the deep palmar arch. J Interv Cardiol. 2008;21:562-565.
9. de Andrade PB, Rinaldi FS, de Castro Bienert IR, et al. Safety and feasibility of ulnar access after failure of ipsilateral radial access. Rev Bras Cardiol Invasiva (English Edition). 2014;22:5-9.
10. Sattur S, Singh M, Kaluski E. Trans-ulnar catheterization and coronary interventions: from technique to outcomes. Cardiovasc Revasc Med. 2017;18:299-303.
11. Hahalis G, Tsigkas G, Xanthopoulou I, et al. Transulnar compared with transradial artery approach as a default strategy for coronary procedures: a randomized trial. The transulnar or transradial instead of coronary transfemoral angiographies study (the AURA of ARTEMIS Study). Circ Cardiovasc Interv. 2013;6:252-261.
12. Agostoni P, Zuffi A, Faurie B, et al. Same wrist intervention via the cubital (ulnar) artery in case of radial puncture failure for percutaneous cardiac catheterization or intervention: the multicenter SWITCH registry. Int J Cardiol. 2013;169:52-56.

13. Mangin L, Bertrand OF, De La Rochelliere R, et al. The transulnar approach for coronary intervention: a safe alternative to transradial approach in selected patients. J Invasive Cardiol. 2005;17:77-79.
14. Aptecar E, Dupouy P, Chabane-Chaouch M, et al. Percutaneous transulnar artery approach for diagnostic and therapeutic coronary intervention. J Invasive Cardiol. 2005;17:312-317.
15. Rath PC, Purohit BV, Navasundi GB, et al. Coronary angiogram and intervention through transulnar approach. Indian Heart J. 2005;57:324-326.
16. Aptecar E, Pernes JM, Chabane-Chaouch M, et al. Transulnar versus transradial artery approach for coronary angioplasty: the PCVI-CUBA study. Catheter Cardiovasc Interv. 2006;67:711-720.
17. Gokhroo R, Bisht D, Padmanabhan D, et al. Feasibility of ulnar artery for cardiac catheterization: AJmer ULnar ARtery (AJULAR) catheterization study. Catheter Cardiovasc Interv. 2015;86:42-48.
18. Li YZ, Zhou YJ, Zhao YX, et al. Safety and efficacy of transulnar approach for coronary angiography and intervention. Chin Med J (Engl). 2010;123:1774-1779.
19. Liu J, Fu XH, Xue L, et al. A comparative study of transulnar and transradial artery access for percutaneous coronary intervention in patients with acute coronary syndrome. J Interv Cardiol. 2014;27:525-530.
20. Andrade PB, Tebet MA, Andrade MV, et al. Primary percutaneous coronary intervention through transulnar approach: safety and effectiveness. Arq Bras Cardiol. 2008;91:e49-52, e41-44.
21. Chugh SK, Chugh Y, Chugh S. How to tackle complications in radial procedures: tip and tricks. Indian Heart J. 2015;67:275-281.
22. Kedev S, Zafirovska B, Dharma S, Petkoska D. Safety and feasibility of transulnar catheterization when ipsilateral radial access is not available. Catheter Cardiovasc Interv. 2014;83:E51-60.
23. Geng W, Fu X, Gu X, et al. Safety and feasibility of transulnar versus transradial artery approach for coronary catheterization in non-selective patients. Chin Med J. 2014;127:1222-1228.
24. Vassilev D, Smilkova D, Gil R. Ulnar artery as access site for cardiac catheterization: anatomical considerations. J Interv Cardiol. 2008;21:56-60.
25. Knebel AV, Cardoso CO, Correa Rodrigues LH, et al. Safety and feasibility of transulnar cardiac catheterization. Tex Heart Inst J. 2008;35:268-272.
26. Kwan TW, Ratcliffe JA, Chaudhry M, et al. Transulnar catheterization in patients with ipsilateral radial artery occlusion. Catheter Cardiovasc Interv. 2013;82:E849-55.
27. Deshmukh AR, Kaushik M, Aboeata A, et al. Efficacy and safety of transulnar coronary angiography and interventions—a single center experience. Catheter Cardiovasc Interventions. 2014;83:E26-31.
28. Dahal K, Rijal J, Lee J, et al. Transulnar versus transradial access for coronary angiography or percutaneous coronary intervention: a meta-analysis of randomized controlled trials. Catheter Cardiovasc Interv. 2016;87:857-865.
29. de Andrade PB, Tebet MA, Nogueira EF, et al. Transulnar approach as an alternative access site for coronary invasive procedures after transradial approach failure. Am Heart J. 2012;164:462-467.

Safi U. Khan, MD
Resident Physician
Internal Medicine Department
Robert Packer Hospital and Guthrie Health Group
Sayre, Pennsylvania
Disclosures: None.

Michael DePersis, DO
Cardiology Fellow
Robert Packer Hospital and Guthrie Health Group
Sayre, Pennsylvania
Disclosures: None.

Edo Kaluski, MD, FACC, FESC, FSCAI
Director of Cardiac Catheterization Laboratories
Robert Packer Hospital and Guthrie Health Group
Sayre, Pennsylvania
Professor of Medicine
Rutgers New Jersey Medical School
Newark, New Jersey
Professor of Medicine
The Commonwealth Medical College
Scranton, Pennsylvania
edo.kaluski@guthrie.org
Disclosures: None.