Navigating the Radial Path to Coronary Enlightenment

Impediments to central aortic access that may occur with the transradial approach and methods to overcome them.

BY RONALD P. CAPUTO, MD, FACC, FSCAI

Transradial access (TRA) has demonstrated several significant benefits when compared to transfemoral access.[1] This has led to an extensive experience with TRA worldwide and a growing interest within the United States. The benefits of TRA, however, are tempered by an increase in operator technical demand that is distinct from transfemoral access.[2-4]

One aspect of TRA that requires additional technical consideration is the occasional difficulty encountered when navigating the vasculature between the point of access (radial artery) and the central aorta. In one series of 2,100 patients undergoing TRA catheterization, Hong et al reported a 4.7% procedural failure rate with an inability to advance the catheter to the central aorta being responsible for 51% of failed procedures.[5] Other case series report this problem in up to 8% of TRA cases.[6-8] Knowledge of the potential causes of this problem and the specific steps for its resolution are important to successfully complete the procedure without the need for a secondary point of arterial access.

INITIAL APPROACH TO THE PROBLEM

When resistance to catheter advancement occurs, there are two important initial—often related—considerations: the anatomic location of resistance and the cause of resistance. Elucidation of these two components will allow for the successful formulation of a solution. Difficulty in catheter advancement can occur at any point in the arterial geography—from the distal end of the sheath to the aortic arch. Arterial obstruction can be categorized according to the following causes: congenital (loops, etc.), functional (spasm), traumatic (dissection), acquired (tortuosity, etc.), and atherosclerotic (Table 1). Because different causes of catheter impedance tend to occur at different points in the arterial anatomy, it is helpful to determine the exact location of resistance. This can be easily determined fluoroscopically by performing angiography at low pressure with half-strength diluted contrast. Contrast can be delivered either through the sheath or through a small catheter (4 F) inserted to the level of the obstruction. Angiography clearly delineates the cause and arterial level of the obstruction and allows for the formation of a specific treatment plan.

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AREAS OF RESISTANCE

Radial Artery

Spasm is the most common cause of impeded catheter advancement at this level and continues to occur in 3.8% to 9.5% of cases despite pretreatment with

TABLE 1. IMPEDIMENTS BY ARTERIAL LOCATION		
Arterial Location	**Type**	**Frequency**
Radial	Spasm	Common (3.8%–9.5%)
	Tortuosity	Occasional
	Branch vessel	Occasional (hydrophilic wires)
	Entry dissection	Rare
	Congenital (loop)	Rare
	Hypoplasia	Rare
Brachial	Spasm	Uncommon
	Atherosclerosis	Uncommon (PVD/previous cutdown)
	Accessory radial	Rare
Axillary	Tortuosity	Occasional (elderly/hypertensive)
	Branch vessel entry	Occasional
	Spasm	Rare
	Atherosclerosis	Rare (PVD/diabetes/elderly)
Subclavian/innominate	Tortuosity	Common
	Atherosclerosis	Rare (PVD/unequal pulses)
Aorta	Arteria lusoria	Rare (< 0.5%)
Abbreviations: PVD, peripheral vascular disease.		

antispasm medications.[9-13] Spasm has been reported to be associated with multiple arterial access attempts, a lack of prophylactic administration of an antispasm "cocktail," a large sheath/artery size ratio, high patient anxiety (possibly related to catecholamine levels), nonhydrophilic sheaths, and multiple catheter exchanges. Radial artery spasm is also a byproduct of arterial dissection. Relief of spasm is achieved with the administration of calcium channel blockers (0.5 mg of verapamil or 0.5 mg diltiazem) and/or nitroglycerin (0.2–0.4 mg) directly into the artery. The use of topical nitrates and warm compresses over the forearm have also been reported as treatments for spasm.[1]

Resulting hypotension is frequent after antispasm medications and should be anticipated and treated with intravenous fluid administration. Liberal administration of anxiolytics and analgesics is also advised because patients with radial artery spasm frequently experience discomfort during catheter manipulation. Resolution of spasm often takes several minutes, and repeat angiography should be performed to assess the artery before reattempting catheter advancement (Figure 1). Insertion of a 0.035-inch or 0.014-inch wire into the central vasculature prior to catheter advancement is also recommended. In extreme cases, a catheter of smaller diameter (4 F) may be required for successful passage through the area of spasm in addition to the previously described maneuvers.

Another complication that can impede passage of the catheter is radial artery dissection. A significant dissection need not preclude discontinuation of the procedure provided the area of dissection can be traversed with a 0.014-inch steerable wire directed into the proximal arterial lumen. If this can be successfully accomplished, further antispasm and analgesic medications should be administered, and the catheter can be advanced over the wire. Occasionally, it is best to use a smaller catheter (4 F) initially and then upsize to a

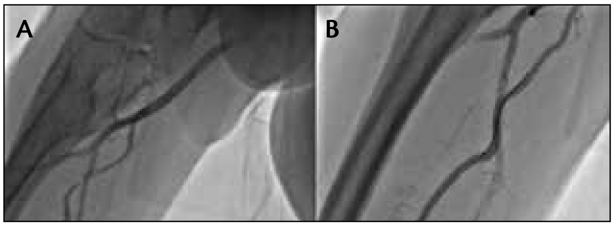

Figure 1. Radial artery spasm with a small, contained dissection (A) with resolution of spasm and dissection after administration of antispasm medication at the completion of the case (B).

Figure 2. The hypoplastic and accessory radial arteries.

larger catheter as needed by exchanging over a wire. Because these dissections are retrograde events, having the catheter in place during the procedure will usually tamponade the dissection causing complete or partial closure by the procedure's end.

After sheath insertion, entry into a small branch vessel at the level of the radial artery is uncommon. Rarely, however, branch vessels are entered as straight-tip wires (usually hydrophilic) exit the sheath. This may occur more often in the presence of spasm. Resistance to wire advancement at this level should be quickly appreciated because continued wire advancement or catheter insertion can result in perforation. In these cases, the wire should be redirected or changed for a J-tip wire. It is often necessary to withdraw the sheath roughly 1 cm so that the wire is no longer directed into the side branch.

Occasionally, the size of the radial artery will prohibit catheter passage. The artery may be small but proportional to the patient's size, or it may be congenitally hypoplastic, which occurs with an incidence of 1.7% to 7.7%.[7,14] A diffusely hypoplastic or small artery can usually be differentiated from spasm, which is usually a more focal event (Figure 2). However, generalized spasm is possible; therefore, treatment with additional medication is prudent. Assessment of ulnar artery size through retrograde sheath injection is also helpful in determining radial artery size. In such a case of a truly small radial artery, the only viable option for continuing the procedure is to downsize to a small 4-F catheter, which unfortunately precludes percutaneous coronary intervention.

The radial artery "loop" is a congenital variation in the proximal radial artery that occurs with an incidence of 0.8% to 2.3%.[8,14] Experienced operators have

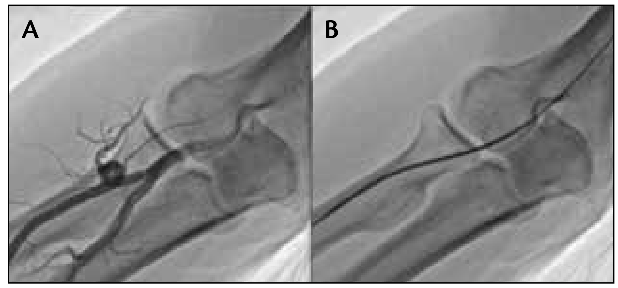

Figure 3. A radial artery loop (A) successfully traversed by a 0.035-inch Versacore wire and a 6-F Sones catheter (B).

demonstrated that catheterization procedures through radial loops can be accomplished, although the true success rate for these types of cases is not known.[15-17] General anatomic criteria for successfully traversing radial loops are large arterial lumen size, small loop size, and lack of acute angulation. Use of a steerable wire is generally required to traverse a radial loop. The 0.035-inch Glidewire (Terumo Interventional Systems, Inc., Somerset, NJ), 0.035-inch Versacore wire (Abbott Vascular, Santa Clara, CA), or a 0.014-inch coronary wire are viable options.

Once a wire has traversed the loop, a catheter can be advanced using the "push-pull" method. The catheter is then rotated clockwise or counterclockwise, reducing the loop and straightening the artery (Figure 3). Once this is accomplished, the procedure can continue. These manipulations are often accompanied by spasm. Therefore, it is recommended that additional antispasmodic and analgesic medications be administered.

Brachial Artery

Resistance to catheter advancement at this level is rare and may be caused by severe angulation, spasm, entry into an early takeoff radial artery, atherosclerotic obstruction, or occlusion related to a previous brachial cutdown. Angulation can usually be traversed

Figure 4. An early take-off radial artery.

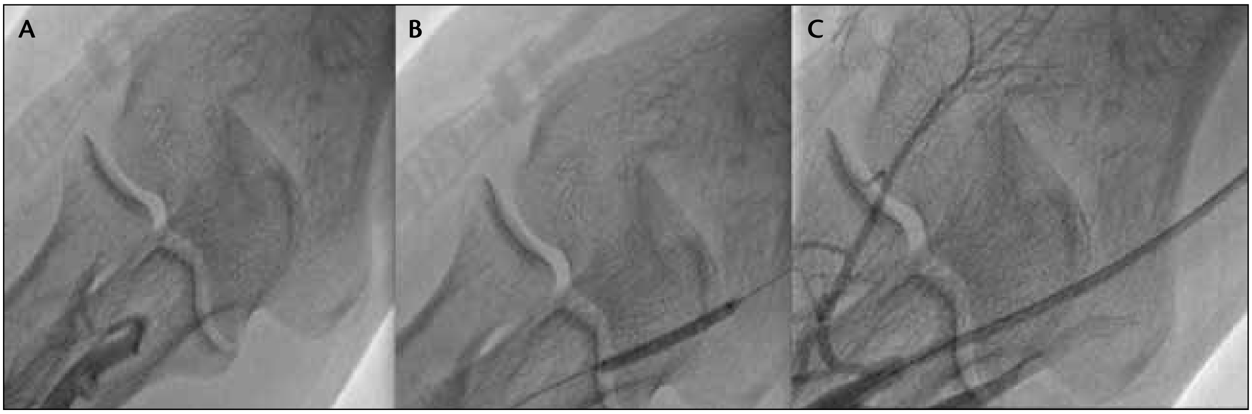

Figure 5. An occluded brachial artery (A) treated with balloon angioplasty over a 0.014-inch wire (B), allowing for successful completion of catheterization via the radial approach (C).

using a steerable wire. Although far less common in the brachial artery, spasm can still occur and must be recognized. Infrequently, an early takeoff radial artery is large enough to accommodate a 5- or 6-F catheter. Early takeoff radial arteries are usually small caliber, and a 4-F catheter maneuvered over a steerable wire may be needed for completion of a diagnostic procedure (Figure 4).

Liberal administration of analgesics and antispasmodics is recommended to attenuate spasm. Obstruction of the brachial artery due to atherosclerotic disease or scar tissue from a previous cutdown procedure may require a change of arterial access site. However, in several instances, we have crossed these lesions with 0.035- and 0.014-inch wires, performed angioplasty with 4- and 5-mm-diameter balloons, and successfully completed the procedure through the recanalized vessel (Figure 5).

Axillary Artery

Impedance to catheter advancement at this level is rare and usually occurs secondary to arterial tortuosity. This is most commonly encountered in elderly and hypertensive patients. Catheters can usually be advanced through the tortuous area after first crossing with a steerable wire. Occasionally, entry into a branch vessel is a cause of resistance, especially when the catheter is advanced either without a wire or over a non–J-tip hydrophilic wire. Steering the wire into the main vessel lumen or changing for a J-tip wire are effective solutions to this problem. Rarely, atherosclerotic disease can result in obstruction to catheter advancement. As with brachial artery occlusion, these obstructions have been overcome with balloon angioplasty using 0.014- or 0.035-inch systems, thereby allowing for completion of the procedure.

Subclavian/Innominate Artery

Due to the prevalence of tortuosity in the subclavian/innominate artery, this is the most common location of resistance to catheter advancement. This becomes an even greater challenge when there is significant calcification, which commonly occurs in elderly, diabetic, and hypertensive patients. This problem occurs most frequently from the right radial approach. Several techniques can be employed to aid in catheter advancement. It is imperative that a wire is used to traverse the area of concern. Versacore, Glidewire, and movable core wires are 0.035-inch wires that can be very effective. Care must be taken to avoid wire advancement into the common carotid artery. Inferior movement of the thoracic contents during a deep breath hold often reduces the angle at which the innominate artery enters the ascending aorta, making it easier to advance the catheter over the wire while

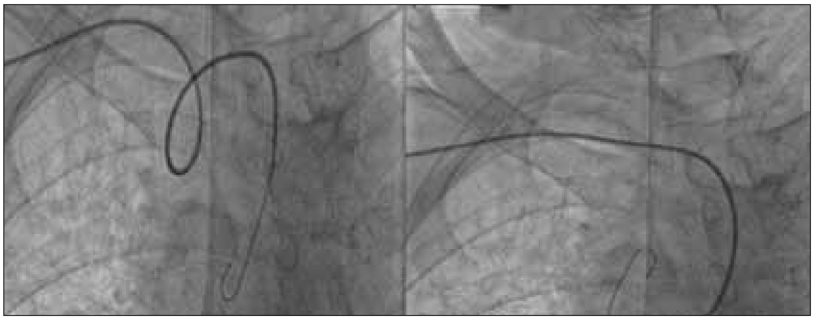

Figure 6. Navigating a tortuous subclavian/innominate with a steerable wire and a deep breath hold.

Although right TRA cases can be successfully completed, they are extremely challenging, and an alternative site of arterial access may need to be considered.

using a push-pull maneuver. It may also help to use a straight catheter (multipurpose, Sones) to navigate the tortuous arterial segment (Figure 6).

One example of extreme angulation encountered from the right radial approach is the arteria lusoria, which is a congenital aberrant retroesophageal right subclavian artery that enters the descending aorta. Arteria lusoria is rare and occurs with an incidence of only 0.2% to 1.7%.[18,19] Although right TRA cases can be successfully completed, they are extremely challenging, and an alternative site of arterial access may need to be considered.

CONCLUSION

Although catheter advancement from the femoral artery to the central aorta is straightforward in the vast majority of cases, resistance to catheter advancement from the radial artery is encountered in roughly 4% to 8% of cases. Causes of impeded catheter advancement can be grouped as congenital, functional, traumatic, or acquired and can occur at any point between the sheath and central aorta. In all cases, diagnostic angiography is useful in elucidating the cause of resistance. After angiographic evaluation, a plan can be formulated for continuation of the case. In many instances, therapeutic and technical maneuvers can allow for continuation of the procedure via the radial approach. Rarely, contralateral radial artery or femoral artery access will be necessary. ■

Ronald P. Caputo, MD, FACC, FSCAI, is Director of Cardiac Services, St. Joseph's Hospital in Syracuse, New York. He has disclosed that he is a consultant to Terumo Interventional Systems, Inc., Boston Scientific Corporation, and Medtronic, Inc. Dr. Caputo may be reached at (315) 448-6215; caputo331@msn.com.

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