Radial Catheter Selection

A guide to catheter selection for transradial coronary angiography and intervention.

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Radial artery access for cardiac catheterization/percutaneous coronary intervention (PCI) has recently gained significant attention due to the associated reduction in bleeding complications with radial compared to femoral access. The major limitation to widespread adoption of radial access is that coronary intubation from a transradial approach is more challenging, and as a result, the learning curve is steep. The widely used preformed catheter shapes are designed to easily find the coronary ostia when used from the femoral artery. When approaching the coronaries from the radial artery, additional considerations apply.

CATHETER SELECTION FOR DIAGNOSTIC CARDIAC CATHETERIZATION

Native Coronary Arteries

Given the widespread familiarity with Judkins catheters, it is not surprising that these remain the most commonly used shapes for coronary angiography, regardless of access site.[1] When using a Judkins approach, the first obstacle to overcome is proximal innominate artery tortuosity and accessing the ascending aorta. Many operators will lead with the Judkins right (JR) catheter so that a 0.035-inch wire can be directed into the aorta, avoiding the vertebral and carotid arteries. Once in the aorta, this curve can also assist in accessing the ascending limb, in some cases aided by a deep breath from the patient. In most cases, a JR 4 will engage the right coronary artery (RCA) using a standard femoral technique, although in some patients, upsizing to a JR 5 from the right radial will allow for more stable intubation. Leading with this catheter also allows the operator to easily obtain a nonselective angiogram of the left main (LM) ostium before engaging with a Judkins left (JL) catheter (Figure 1A). This can be helpful when LM disease is a concern, as occasionally the JL will need to be engaged with the wire still in place. After exchanging catheters, the tip of the JL will typically be in the right coronary cusp. Gentle retraction will result in movement of the catheter into the left cusp and often into the LM ostium. When utilizing the right radial, a JL 3.5 will typically allow better engagement. Unfortunately, the catheter tip may point up to the roof of the LM, and gentle injection is imperative (Figure 1B).

Other femoral catheters, such as the Amplatz shapes, can be helpful when anatomic variations prove challenging for the Judkins shapes. With dilated aortic roots, the larger Amplatz left (AL) curve will often provide the best orientation for engagement of the LM. An anterior RCA is also best approached with an AL 0.75 or 1, as with femoral access. Although the benefits in terms of familiarity with these catheter shapes and engagement techniques are significant, the main disadvantage of using

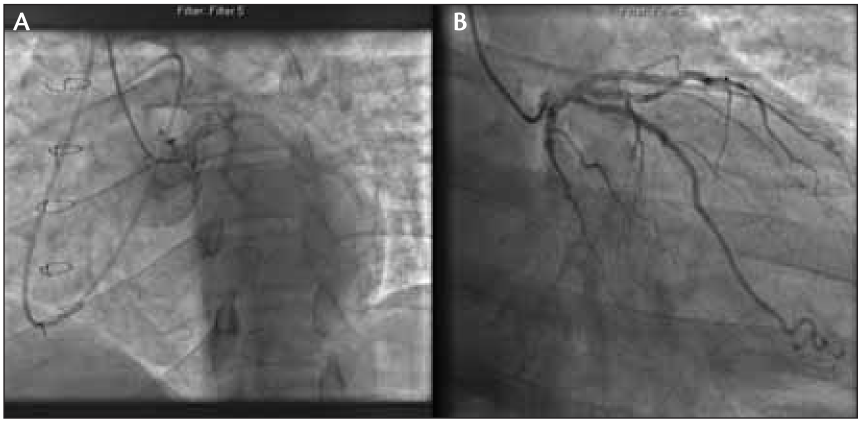

Figure 1. Diagnostic catheterization via the right radial approach with standard femoral shapes. Nonselective injection using the JR catheter reveals a patent LM coronary artery (A). The tip of the JL 3.5 catheter will occasionally be directed at the roof of the LM, and gentle injection is imperative (B).

these catheters is the necessity for multiple catheter exchanges. A higher number of catheter exchanges increases vascular dysfunction and may provoke radial artery spasm, leading to patient discomfort and difficult catheter manipulation.[2] Multiple exchanges can also prolong the procedure duration and increase radiation exposure to the patient and operator.

To avoid the disadvantages of a dual-catheter strategy, some operators prefer to use a single-catheter technique. In the United States, the devices that are most commonly used to engage both left and right coronaries are the Tiger (Terumo Interventional Systems, Somerset, NJ) and the Kimny (Boston Scientific Corporation, Natick, MA) catheters.[1] These catheters were specifically designed to be used from the right radial approach and require a different engagement technique. The shapes of these catheters are similar, as is the technique for intubation of the coronaries (Figure 2A and 2B). When advanced over a guidewire into the ascending aorta, they may end up in either the left or right coronary cusp. In our experience, they typically fall into the right cusp, and engagement of the left cusp requires careful withdrawal until the tip retracts over the right aortic valve leaflet and moves into the left coronary cusp. Depending on the patient's anatomy, the catheter may engage from above with slight clockwise or counterclockwise rotation or, more commonly, may require advancement up the left cusp to engage from below with slight withdrawal at the end to achieve a coaxial position, similar to the typical Amplatz technique. To engage the right coronary, the catheter is then slightly withdrawn from the left, rotated just slightly over the valve, and advanced into the right cusp. Once in the right coronary cusp, slow withdrawal with clockwise rotation will engage similar to the Judkins technique.

Smaller studies have shown these catheters to be safe and effective and suggest that they may reduce fluoroscopy time and total procedure time without sacrificing the quality of angiography.[3,4] However, anatomic variants are common, and just as with femoral catheterization, no single catheter will be successful in every case. It is important to recognize this early and switch to an alternative catheter shape, if needed.

Coronary Artery Bypass Grafts

Previous bypass has been shown to be an independent predictor of transradial failure, but with sufficient operator experience, most patients can undergo coronary angiography via the radial approach after coronary artery bypass graft surgery.[5] The ipsilateral radial artery is used if the mammary artery has been utilized as a conduit. If both the right and left internal mammary arteries (IMAs) have been used, the contralateral IMA can be engaged from the radial artery. In this situation, the patient would be most comfortably approached from the right radial. An IMA catheter will allow for right IMA injection and can then be advanced into the descending aorta over a 0.035-inch wire. The catheter can then be oriented to allow passage of a 0.035-inch hydrophilic wire into the left subclavian, axillary, and brachial arteries. At this point, inflating the brachial blood pressure cuff will provide enough support on the wire to allow the IMA catheter to be advanced into the subclavian artery, and the left IMA can be engaged in the usual fashion.

Saphenous vein grafts (SVGs) from the aorta are typically best approached via the left radial, and most commonly, an AL or JR catheter can be used to reach all the grafts. In some cases, a multipurpose catheter may be helpful, specifically when engaging an inferiorly oriented graft to the RCA.

CATHETER SELECTION FOR PCI

The selection of a guide catheter for coronary interventions involves an additional level of consideration. The initial concerns regarding ease of coronary intubation, coaxial alignment, and the technique to achieve these are identical to those of diagnostic catheters. However, for guides, the importance of backup support to allow delivery of interventional equipment is paramount. Support is derived from the intrinsic stiffness of the guide, as well as contact against the opposite wall of the aorta.

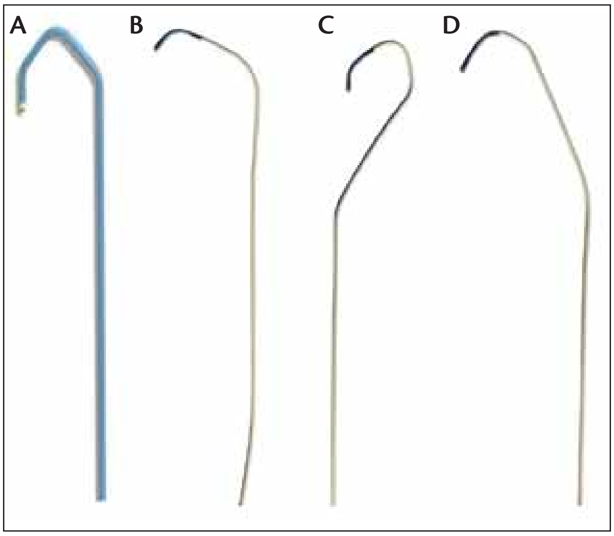

Figure 2. Specialty catheters designed specifically for use via the radial approach: Kimny (A), Tiger (B), Ikari left (C), Ikari right (D).

Left Coronary Intervention

Common catheter shapes, such as the Judkins, XB (Cordis Corporation, Bridgewater, NJ), and EBU (Medtronic, Inc., Minneapolis, MN), provide significantly more backup when used from a femoral approach.[6] Despite this, the common femoral shapes are still the most widely used guide catheters, with XB/EBU and JL being most common for the left coronary.[1] Downsizing slightly to the JL 3.5 has been shown to increase backup support in in vitro studies, but it is unclear if this is true of the XB/EBU shape as well.[6] The Ikari guide (Terumo Interventional Systems) was specifically designed to provide improved backup support from the right radial approach. The Ikari shape was designed for left coronary interventions and takes into account the angle between the brachiocephalic and ascending aorta (Figure 2C).[7] It allows for backup support from the contralateral aortic wall and coaxial engagement of the LM ostium. The catheter will typically enter the left sinus spontaneously, where withdrawal of the wire and occasional clockwise or counterclockwise torque will result in LM engagement.[8] Sizing of this catheter is similar to the JL, with an Ikari left 4 guide being appropriate if a JL 4 was an appropriately sized diagnostic catheter.[9]

Right Coronary Intervention

For the right coronary, the JR is again the most frequently used guide catheter, with the Amplatz right a distant second.[1] Unfortunately, lack of backup support remains an issue, particularly with the JR catheter, which does not contact the contralateral aortic wall at all. Some operators favor "deep-seating" the guide, especially when using a smaller 5-F guide, but there is some risk of dissection with this technique. When additional backup support is needed, a smaller AL 0.75 is useful, and the technique used for engagement is similar to the approach from the femoral artery. Alternatively, the Ikari right catheter may be used (Figure 2D). This catheter's three-dimensional curve takes into account the angles between the innominate and the right coronary ostium, allowing coaxial intubation with backup support from the contralateral aortic wall. When advanced over a 0.035-inch wire, the catheter tip will typically end up in the left coronary sinus. Withdrawing the wire but leaving it in the guide prevents kinking of the catheter while it is gently rotated into the right sinus and into the coronary ostium.[8] The MAC guide (Medtronic, Inc.) is another long-tip guide that provides backup from the contralateral aortic wall in a similar fashion. Although not commonly used, either of these specialty catheters should be considered when more familiar catheters do not provide adequate support.

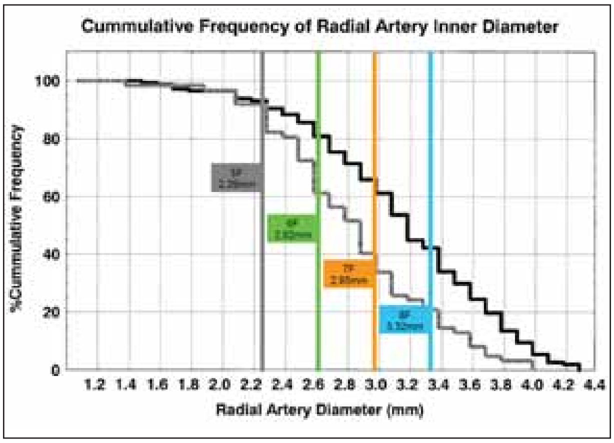

Figure 3. Cumulative frequency of radial artery diameter (solid line: male patients; dotted line: female patients). Colored flags denote the outer diameter of the Glidesheath and Pinnacle (Terumo Interventional Systems) lines of hydrophilic introducer sheaths. Modified with permission from Saito S et al. *Catheter Cardiovasc Interv*. 1999;46:173–178.[10]

Bypass Graft Intervention

IMA interventions are generally performed using an IMA guide from the ipsilateral radial artery. If the lesion to be treated is in the distal IMA or in the native artery beyond the anastomosis, consideration should be given to using a 90-cm guide to ensure that the usable length of balloon and stent catheters will be sufficient to reach the lesion.

Guide support for SVG intervention can be especially difficult due to the location of the grafts and the proximity to the innominate or left subclavian artery. When approached from the right radial, a significant portion of the catheter's curve is located in the innominate artery and does not provide support along the wall of the aorta. For SVGs to left coronary artery vessels, a JR guide can be considered but often will not have a long enough tip to engage the graft and will not provide backup support from the contralateral aortic wall. An AL guide from the left radial provides the best support, but a coaxial position can be difficult to achieve.

For SVG interventions to RCA branches, a JR 4 guide can be considered but has similar limitations as when used for left-sided grafts. Our preference is to use a multipurpose guide, particularly for grafts with an inferior takeoff.

FUTURE DIRECTIONS

An important limitation to radial access is the risk of radial artery occlusion, which occurs in approximately 5% to 10% of patients at discharge, with 2% to 7% persistently occluded at 1-month follow-up.[11,12] A major predictor of radial artery occlusion is a larger ratio of

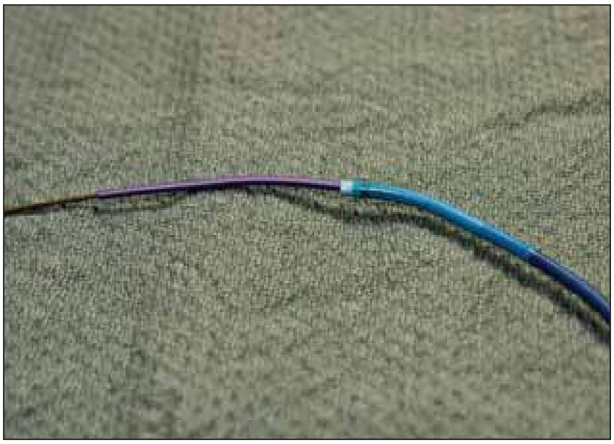

Figure 4. Sheathless technique. A 5-F multipurpose diagnostic catheter acts as a dilator for a 7-F JR guide catheter and is advanced into the ascending aorta over a standard 0.035-inch J-tip wire. The external diameter of the 7-F guide is the same as the external diameter of a 5-F introducer sheath.

sheath diameter to radial artery diameter, and therefore, investigation is ongoing to improve sheath and guide technology so that PCI can be performed via a smaller profile.[10,13] Although 5-F catheters may provide less backup support and more difficult angiographic visualization, they have the advantage that they can often be easily and safely advanced deep into the coronary artery, thereby providing excellent support for device delivery. Of course, many devices cannot be delivered through a 5-F guiding catheter.

Nearly all PCIs can be successfully completed with a 6-F system, including cases involving thrombectomy, rotational atherectomy, and bifurcation balloon angioplasty and stenting with the "Culotte" technique. The majority of adult patients will have radial arteries that can accommodate such equipment (Figure 3).[10] However, there are cases in which the operator will need a larger guiding catheter either for enhanced support or additional space for multiple wires, catheters, and stents. Unfortunately, with the use of larger sheaths, the risk of radial artery occlusion increases.[13] In an effort to maintain a smaller profile, several operators have described the use of the "sheathless" guide technique.[14] Once radial access is achieved and a 0.035-inch wire is advanced into the ascending aorta, a 7-F guide can then be advanced over a 5-F, 125-cm diagnostic catheter (such as a multipurpose shape) that acts as a dilator (Figure 4). Once in the ascending aorta, the guide can be advanced over the inner dilator catheter and into the coronary artery. This technique allows for larger guide diameter with less radial trauma. For instance, a 7-F guide catheter has the same outer diameter as a 5-F sheath. Guide technology must continue to improve with the development of hydrophilic-coated guides and better dilator technology for sheathless PCI to more readily come into practice.

CONCLUSION

With the increasing use of radial artery access for PCI, it is important for operators to become familiar with currently available and emerging technologies. Appropriate application of techniques and technology to the various clinical scenarios and diverse patient populations will allow physicians to achieve optimal results with transradial intervention. ■

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