Ten Common (and Uncommon) Reasons for Unsuccessful Transradial Procedures

Understanding the limitations of radial access is key to optimal application.

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Over the past decade, an increasing number of percutaneous coronary procedures have been performed via the radial artery rather than the femoral artery. This has been primarily due to benefits in patient safety and comfort. The use of radial access (RA) has not been incorporated into peripheral vascular procedures to the same degree. There are several potential explanations for this, including issues of specialty training and local practice culture, which are outside of the scope of this manuscript. Nonetheless, it is important to understand the limitations of RA and the circumstances in which an alternative arterial access strategy may be preferable. In this article, we provide an overview of these limitations, broken down by patient-related, anatomic, and procedural factors (Table 1).

PATIENT-RELATED FACTORS

Obtaining a thorough preprocedural history and examination are key to identifying many absolute and relative contraindications to RA. Certain general patient characteristics, including age > 75 years, short stature, and female sex, as well as previous coronary artery bypass grafting (CABG) and cardiogenic shock, have all been reported as independent risk factors for RA failure and are worth bearing in mind. None of these independent factors are a contraindication to RA. However, there are still several potential patient-related contraindications to consider.

Fistulas, CABG, and Other Iatrogenic Anatomic Changes

The known presence of an arteriovenous fistula or graft is generally a contraindication; however, in very rare instances, cannulation of the artery proximal to the fistula site is possible if no other access site is available. Some have advised avoiding access on the side of a planned hemodialysis graft or if the artery of entry is expected to be used as a coronary artery bypass conduit in an upcoming surgery. Similarly, history of major surgery in the targeted upper extremity or previous malignancy (particularly breast cancer) treated with chest wall/extremity radiation or a mastectomy can distort vascular anatomy. In many of these scenarios, the contralateral side is usually suitable for access.

Similarly, in patients who have undergone CABG with a left internal mammary artery graft that needs to be examined, the default site of access is the left radial artery. A left-sided approach provides a more direct path for the catheter to follow and thus improves the operator’s capacity to engage the vessel.

Vasculitis and Abnormal Vascular Tone

Known vasospastic diseases such as Raynaud syndrome and Buerger disease are relative contraindications. Other inflammatory conditions such as scleroderma and systemic lupus erythematosus can also pose a challenge for upper extremity access. When these conditions are present, the vessels are more prone to spasm and are
often smaller in caliber. In the critically ill population, high peripheral vascular tone, as seen in cardiogenic shock, can result in difficulty with distal arterial access; although not a contraindication, it is prudent to prepare an alternative access site in patients with cardiogenic shock. Ultrasound can assist with location of the vessel and increase the likelihood of successful access.

**Previous Access Failure**

Finally, reviewing prior catheterization records can alert providers to previous major complications or challenges with a particular access site, such as arterial dissection/perforation, excessive tortuosity, or other vascular anomalies.

**ANATOMIC FACTORS**

The radial artery bifurcates from the brachial artery in the antecubital fossa and runs along the lateral, anterior arm, parallel with the ulnar artery and adjacent to the radial vein. After passing through the anterior wrist where this artery is typically cannulated, it curves posteriorly through the snuffbox and eventually combines with the ulnar artery to form the deep palmar arch.

**Skin Abnormalities**

The initial step to assessing patient candidacy for RA is simply to examine the skin over the expected cannulation site. As with vascular access of any kind, evidence of superficial infection (cellulitis, abscess) or compromise to skin integrity (burns, wounds) should prompt identification of an alternative access site.

**Dual Circulation**

It has been common practice to confirm dual circulation of the hand via the Allen or Barbeau test. However, there is little evidence to support the ability of such noninvasive testing to predict hand ischemia. The RADAR trial showed no occurrences of hand ischemia after RA (as assessed by the thumb capillary lactate level) and no relationship of a normal or abnormal Allen test to hand ischemia outcomes. Consequently, an abnormal Allen or Barbeau test may not exclude patients from RA.

**ANATOMIC FACTORS IN OTHERWISE ELIGIBLE PATIENTS**

The next three anatomic factors can lead to RA failure, even if the patient is otherwise an appropriate candidate for the radial approach. Because of the frequency with which these issues are encountered, they have been included here along with some simple troubleshooting strategies.

**Vessel/Patient Size**

Deviations from expected vascular anatomy can prove problematic. In smaller patients, particularly petite women, the radial artery may be small (< 2 mm); this can make both cannulation and sheath insertion difficult. An ultrasound-guided approach may increase the likelihood of success in these patients. In larger patients or those with joint conditions that make hyperextended wrist positioning difficult to tolerate, a more comfortable option may be snuffbox access with the dorsum of the hand resting on the abdomen.

**Ulnar access** is occasionally useful when RA is not feasible; however, the supporting literature for ulnar and dorsal access is not as robust as for traditional RA.

**Vasospasm**

Vasospasm is among the most common causes of RA failure. Even if the radial artery is structurally of a reasonable size, vasospasm can be painful and prohibitive to

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**TABLE 1. ABSOLUTE AND RELATIVE CONTRAINDICATIONS TO RADIAL ARTERY ACCESS**

<table>
<thead>
<tr>
<th>Patient Factors</th>
<th>Anatomic Factors</th>
<th>Procedural Factors</th>
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</thead>
<tbody>
<tr>
<td>• Existing AV fistula or graft</td>
<td>• Skin infection or compromised integrity</td>
<td>• Need for devices that require large (&gt; 7 F) access sheaths</td>
</tr>
<tr>
<td>• Prior CABG with need to engage LIMA (left radial preferable to right radial)</td>
<td>• &lt; 2-mm artery size</td>
<td>• Excessive distance to target intervention site</td>
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<tr>
<td>• Anticipated use of radial artery for AV graft or as CABG conduit</td>
<td>• Intolerance of hyperextended wrist positioning</td>
<td></td>
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<tr>
<td>• Previous major surgery to forearm or wrist</td>
<td>• Severe vasospasm</td>
<td></td>
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<tr>
<td>• Previous malignancy treated with chest wall/extremity radiation or mastectomy</td>
<td>• Vessel tortuosity</td>
<td></td>
</tr>
<tr>
<td>• Vasculitis</td>
<td>• Radial loops</td>
<td></td>
</tr>
<tr>
<td>• Previous access failure</td>
<td>• Absent or occluded radial artery</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Atherosclerotic or calcific PAD</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Absence of dual circulation on noninvasive testing (controversial)</td>
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</tbody>
</table>

*Abbreviations: AV, arteriovenous; CABG, coronary artery bypass grafting; LIMA, left internal mammary artery; PAD, peripheral artery disease.*
successful cannulation. Using ultrasound guidance early to avoid repeat arterial punctures can prevent spasm. Once the sheath has been inserted, giving an antispasmodic agent, such as verapamil or nitroglycerin intraarterially, can decrease the risk or severity of vasospasm.

**Tortuosity, Loops, and PAD**

Excessive tortuosity between the subclavian and radial artery, the presence of radial loops, and atherosclerotic or calcific peripheral artery disease (PAD) can result in difficulty advancing wires and catheters into distal vascular territories (Figure 1). Often, vascular anomalies are identified after the radial artery has been accessed when a guidewire encounters resistance in the arm. It is imperative that with any degree of resistance, particularly if the patient is reporting pain, further advancement of the sheath or guidewire be halted to prevent dissection or perforation of the artery. Perforation can lead to rapid bleeding, hematoma formation, and possible compartment syndrome.

If resistance is encountered, a number of strategies can facilitate the radial approach. Inserting the radial sheath (even incompletely) can allow dye injection and visualization of arterial anatomy under fluoroscopy. A smaller-diameter, angled, steerable hydrophilic wire can sometimes be advanced more easily through tortuous or narrow vessels. More experienced operators may consider using balloon-assisted tracking, wherein a partially inflated balloon leads the catheter tip to prevent trauma to the vessel. Alternatively, as radial loops are rarely bilateral, it may be more successful to reattempt access via the left radial artery.

**PROCEDURAL FACTORS**

The final procedural goal is integral when choosing the optimal arterial access strategy. Although the vast majority of cases are for straightforward diagnostic coronary or peripheral angiography in stable patients and can typically be performed radially, some exceptions require femoral arterial access.

**Need for Devices That Require Large Access Sheaths**

Some coronary or cardiac applications require large-bore arterial access for the deployment of hemodynamic support devices, percutaneous aortic valves, and defect closure devices. It is similarly important to assess the caliber of sheath or catheter required to deliver the intended therapy in endovascular procedures, as these factors may preclude radial artery use.

Patient sex is a factor to consider when looking at radial artery size, because women have smaller arteries than men; geographic variation in radial artery caliber should also be considered. Inserting sheaths larger than the arterial diameter can cause stretching, injury, and vessel occlusion. This can be avoided by using ultrasonography to define arterial diameter prior to the procedure and using thin-walled sheaths that offer larger internal diameters while maintaining smaller external diameters.

**Distance From Access Site**

For some peripheral vascular interventions, current radial devices are not universally available in sufficiently long lengths to reach the area of interest. However, currently available equipment does allow diagnostic angiography to be performed anywhere in the body using RA. From an interventional perspective, the carotid, subclavian, and mesenteric territories are also accessible from either radial artery.

As for the lower extremities, a small group of endovascular devices have been recently introduced that are specifically designed for use in RA procedures. They are, however, restricted to the iliac and superficial femoral arteries. Market penetration is still low as therapeutic
options are limited at this point. There is growing interest in tibiopedal access as an alternative site for lower extremity interventions. This site is similar to the radial artery in terms of access technique, sheaths and equipment, and closure strategy.

CONCLUSION

RA has substantial benefits over the femoral approach and can be successfully used in the large majority of cases. As with any procedure, it is important that the operator be aware of contraindications, limitations, and complications so that suitable candidates can undergo safe, efficient procedures.


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