

Radial Access Challenges

Techniques to maximize success when entering and exiting the radial artery.

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Invasive cardiovascular procedures can be successfully performed from either the femoral or radial approach. Although much of the procedure is similar for either approach, once central access is achieved, the challenge encountered most frequently with the radial approach is the actual access as opposed to the closure or hemostasis that vexes femoral access. An effective radial access technique can ensure a successful procedure, and a proper radial hemostasis technique can reduce radial artery occlusion and maintain the option for further radial access in the future.

RADIAL ACCESS

Radial access, or alternatively ulnar access, is feasible in just about every patient who presents to an experienced radial operator. Many radial-first operators are able to report procedural success rates > 90%. There are still some procedures involving > 6-F equipment that may not be routinely feasible from the wrist, but most routine, standard interventional procedures can be accomplished from the radial approach. Failure to accomplish a successful transradial procedure in a patient with a palpable pulse is rare in experienced hands and usually involves either an unforeseen vascular loop or other severe tortuosity.¹ Although solutions to these challenges exist, ultimate success is usually achieved using the contralateral radial artery.

Allen Test

Much has been discussed about the Allen test and other measures of collateral blood flow in the hand. This has produced a ritualistic interest in the status of these results by some operators, yet many high-volume operators around the world do not rely on this test, as it has not been found to reflect a measurable outcome with either radial arterial lines or radial catheterization.² Although

there may not be a hazard to testing the hand prior to the procedure, an abnormal test result might tempt the radial operator to use a femoral approach, subjecting the patient to the known risks of femoral puncture in order to prevent a hypothesized, but never measured, risk from radial catheterization. Rather than focusing attention on their wrist and its wealth of collaterals (Figure 1), patients are better served by maintaining the focus on the heart and the primary concerns that brought the patient to medical attention.

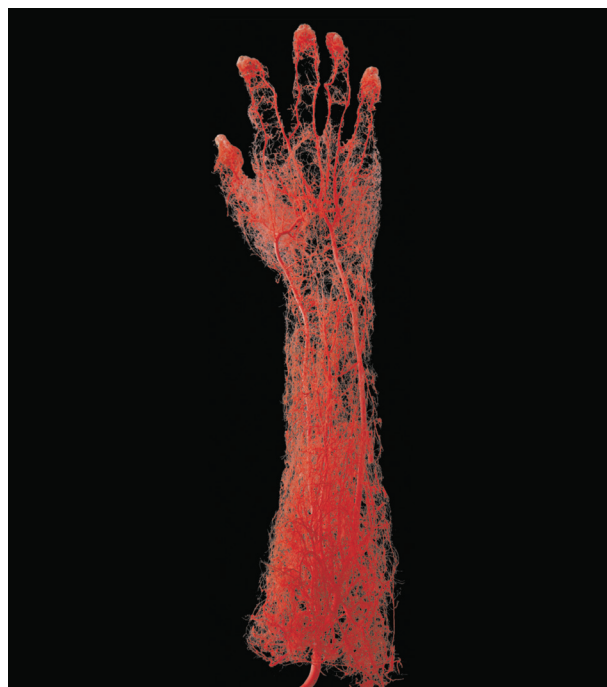


Figure 1. Arterial vascularity of the forearm and hand. Used with permission: Gunther von Hagens' BODY WORLDS, Institute for Plastination, Heidelberg, Germany, www.bodyworlds.com.

TABLE 1. ARTERIAL PUNCTURE TECHNIQUES

	Single Puncture	Double Puncture	
		Traditional	Modified
Puncture device	Hollow, beveled needle	Angiocath	Hollow, beveled needle
Arterial puncture	Anterior	Anterior and posterior	Anterior and posterior
Action after puncture	Wire introduced into artery	Trocar removed and plastic catheter pulled back into artery lumen before passing wire	Needle pulled back into artery lumen, released to align coaxial, then wire introduced through needle into artery
Advantage	Logical extension from femoral technique; simple	Double puncture is easier for those without femoral experience; plastic catheter is atraumatic	Double puncture is easier for those without femoral experience; simpler than using Angiocath
Disadvantages	Difficult to gauge location in small-diameter radial artery	Adds complexity to procedure	More complex than simple anterior puncture

Environmental Preparation

Successful cannulation in expert hands is a culmination of a series of small steps that contribute to extremely high success rates. Most of these steps are logical extensions from basic physiologic principles of vascular pathophysiology. In particular, drivers of arterial constriction including anxiety, temperature, and mechanical and pharmacologic influences can all be controlled to the operator's advantage. A relaxed patient, whether the end result of pharmacologic or non-pharmacologic approaches, should be a common setting for success.³ The wrist should be positioned to present the radial artery to the operator typically in a slightly extended position, but not extended to the point of orthopedic pain to the patient. Warmth, be it ambient room temperature or locally applied, can counter cold pressor effects on the artery. Likewise, solutions or cocktails injected into the radial artery should not be cold, as this will induce spasm.

Local Anesthesia

Anesthesia of the skin using a local subcutaneous injection of anesthetic or locally applied cutaneous anesthetic cream sets the stage for a procedure with minimal discomfort. Sharp pain early in the access sequence will not endear the patient's confidence in the operator and will increase vascular tone. Deep use of large volumes of anesthetic into the periradial artery space is also not a good approach because it may result in mechanical compression of the artery, and its acidic nature may be responsible for anesthetic-associated spasm.⁴ The goal of local anesthesia is to block pain at the skin level and should only require < 0.5 mL of typical anesthetic.

Arterial Sheaths

Arterial puncture is best performed with one of the widely available micropuncture systems coupled with

an appropriately designed vascular sheath. The vascular sheath will be best tolerated if it is hydrophilic coated and only as large in diameter as needed for the procedure.^{5,6} Newer thin-walled sheaths, such as the Glidesheath Slender (Terumo Interventional Systems) that accepts 6-F devices yet has a profile of a 5-F, is an example of redesigning the vascular sheath using a thinner wall. Sheathless systems, such as the SheathLess Eaucath guiding catheters (Asahi Intecc), are entering the market and have the advantage of a smaller external diameter at the entry site.⁷ To date, whether the net advantages of these systems will outweigh potential hazards is unclear and should be the subject of future investigation.

Ultrasound Guidance

In general, the trend in vascular access has been to use ultrasound guidance for precise puncture. This has been reported in the radial field but is not widely practiced. Given improved ultrasound systems that may be more easily used for shallow access at the radial artery, the future of successful access will probably rest on the use of this technology. Ultrasound can not only specifically localize the artery,⁸ but in experienced hands, it can be used to identify characteristics of the radial artery, such as high bifurcations or radial loops, which might alter the choice of access.⁹ Today, most operators still rely on tactile location of the radial artery.

Single- or Double-Wall Puncture

Compared to the femoral artery, the radial artery represents a small target. Although the standard modified Seldinger technique uses a single-wall puncture at the level of the femoral artery to avoid the potential risk of

TABLE 2. FACTORS TO REDUCE ARTERIAL SPASM

Psychological	Calm, relaxed patient (sedated or otherwise)
Environmental	Warm extremity, well-positioned arm
Pharmacologic	Nitrates and/or calcium channel blockers
Equipment	Hydrophilic coatings (sheaths, catheters, wires)
Procedural	Efficient use of movement within artery

the posterior wall puncture acting as a source for hemorrhage, radial operators don't face this hazard of a posterior puncture in the radial artery. A spectrum of techniques has been described (Table 1) as being very successful in the hands of the right operator. At one extreme, there are operators who have successfully transplanted their modified Judkin approach from the femoral to the radial artery, which appears successful in an anterior wall puncture technique. At the other end of the spectrum, there is a technique using double-wall puncture with a small Angiocath device (Moore Medical). Under this technique, the artery is punctured "through and through" with the Angiocath, and the central trocar is then removed, leaving the plastic catheter embedded through the artery. The plastic catheter is then gently pulled back into the vascular space, and when pulsatile flow is noted, the vascular sheath wire is inserted into the radial artery via the plastic catheter. The plastic catheter used for access is removed off the wire, and a radial sheath passes over the wire into the artery.¹⁰

A compromise to these two approaches offers the benefits of both. This approach involves taking a standard micropuncture needle, and instead of a single-wall puncture, it is passed through both the anterior and posterior wall. The operator then slowly withdraws the needle until pulsatile flow is noted. At this point, the needle can be gently released, and it will tend to orient itself coaxially in the radial artery. The muscular walls of the artery will prevent the needle from falling out of the artery when released. The operator then gently regrips the needle in its new orientation and passes the vascular sheath wire up the radial and subsequently replaces the needle for the actual vascular sheath. This approach avoids the extra step of using an Angiocath and its trocar, yet still maintains the use of a double-wall puncture that, at least for many, appears to be an easily learned technique.

Antispasm Regimens

After the vascular sheath is safely in the radial artery, many operators instill a pharmacologic agent to preempt

further vascular spasm. Although a variety of agents have been used, superiority in a properly powered trial has not been clearly shown. Pharmacologically, nitrates would be expected to have a shorter half-life than calcium channel-blocking agents. All of these agents are active in the radial artery. Many are acidic and should be buffered with blood. The burning sensation experienced by patients with administration of poorly buffered antispasm medications is a local effect from the acid pH that may potentially damage endothelium and contribute to radial occlusion. Likewise, cold injectate may also induce spasm, and thus, use of prewarmed solutions into the radial artery makes physiologic sense.

The routine use of antispasm medications has recently been questioned by several experts. It has been a long-standing observation that the problem of spasm appears to markedly decrease with an operator's growing experience. Taken to its conclusion, some experienced operators have reported success without the routine use of antispasm medications.¹¹ Their success points to the multiple factors that drive radial spasm and that an optimal approach with attention to multiple factors contributes to success rather than any one dogmatic step (Table 2).

Once access is achieved, ultimate access site success is declared when one delivers the catheter to the central arterial system. Resistance to wire passage up from the wrist is not normal and should be cause for investigation. Blindly pushing wires against resistance is an invitation for perforation or mechanically induced spasm. A low threshold for a local angiogram can rapidly define the problem and facilitate a solution that will add efficiency to the procedure. In the rare case in which an unusual loop or anatomic variant is too challenging, rapid alternative access can be sought, and little time and effort is wasted. Vascular loops and tortuosity are not bilaterally defined in the upper extremity, and the contralateral arm is often the best alternative.

RADIAL HEMOSTASIS

Although obtaining radial access is paramount to the acute success or failure for the procedure, radial hemostasis plays an important role in maintaining the long-term function of the radial artery. Radial hemostasis is not as acutely important to prevent complications as it is with femoral access, but careful attention to detail in hemostasis will minimize the risk of radial artery occlusion. Although radial artery occlusion is not an acute disaster, attempts to prevent it are worthwhile to minimize radial artery loss and to maintain the potential to reuse the artery in the future (see the *Tips for Reducing Radial Artery Occlusion* sidebar).

TIPS FOR REDUCING RADIAL ARTERY OCCLUSION

- Minimize spasm
- Minimize equipment diameter to smallest feasible
- Intravenously anticoagulate all patients undergoing radial procedures
- Remove sheaths promptly after procedure
- Practice patent hemostasis
- Minimize length and degree of hemostasis
- Minimize barotrauma to artery
- Encourage radial arterial flow (ulnar compression)

Patent Hemostasis

Once the sheath has been removed, patent hemostasis can reduce the chances of postprocedural radial occlusion to < 1%. The goal of this approach is to maintain some flow through the radial artery, if possible, while hemostasis at the puncture site proceeds. Doing so not only permits a steady flow of clotting factors to the site of vascular puncture, but also limits the crush pressure on the artery and the potential for barotrauma to the vascular structures. A technique has been described by Pancholy et al using careful titration of vascular hemostatic band pressure based on observation of signs of perfusion.¹² A similar concept has been described by using titration to mean blood pressure.¹³ In this approach, the pressure in the air bladder of the hemostasis band is measured with a small manometer and maintained at the mean arterial blood pressure with the net effect of allowing systolic perfusion of the artery. Although this has not been as widely tested as the titrated band pressure approaches, it is quite similar in net effect on perfusion during hemostasis.

Radial Artery Occlusion

Acutely, an occluded radial artery may be reperfused under the influence of ulnar occlusion.¹⁴ Most cases of acute radial artery occlusion will otherwise spontaneously regain perfusion within the next 30 days. Antiplatelet therapy, especially in those not already on it, may help improve outcomes. Mechanical reperfusion is possible but not recommended, even by those who have reported it, because there is a risk of distal fingertip infarction. Regimens with antithrombotic therapy, such as low-molecular-weight heparin or oral agents, have

also been described, but not widely followed. The risk of acute ischemia from a radial artery occlusion is most unusual and would be the only indication for potentially involving a vascular surgeon. Asymptomatic radial occlusions are not vascular emergencies and can only be made worse by surgical intervention.

CONCLUSION

The radial artery should not be considered a small femoral artery, and the difference in access challenges between these two approaches for arterial catheterization is reflective of this. Radial access is the critical step in performing a transradial procedure, whereas radial hemostasis plays a minor role versus the potentially lethal complications that can arise when femoral hemostasis goes awry. On the other hand, radial hemostasis becomes critical in preserving the function of the radial artery so that the radial artery remains functional in the long run and available in the future as an access site. ■

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