Femoral Versus Radial Access: Do Vascular Closure Devices Level the Playing Field?

A look at the pro and cons of radial versus femoral access and the extent to which VCDs can mitigate drawbacks of a femoral approach.

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The evidence base is compelling: outcomes after radial access are superior to those after femoral access in most (but not all) clinical settings. Lower complication rates, including mortality, have led to expanding adoption of the radial approach and a sharp decline in femoral access in much of the world, including the United States. As a result, two studies published in the past 2 years have raised the question: can using vascular closure devices (VCDs) after femoral access level the playing field? Alonzo et al and Andrade et al compared radial access to the combination of femoral access plus VCD use to prove non-inferiority.[1,2] Unfortunately, those studies were flawed to an extent that they could not provide a high-level, evidence-based conclusion.[3,4] The hypothesis has been that the superiority of radial access results from complications that can be mitigated by the use of VCDs and that the clinical and economic drawbacks associated with the femoral approach (ie, prolonged bed rest and delayed ambulation and discharge) can also be addressed with VCD use.

PROS AND CONS OF VCD USE

I have previously presented the pros and cons of VCDs in this publication.[5] Studies that show superior outcomes with VCD use compared with manual compression have suffered from substantial selection bias. Registries, such as the National Cardiovascular Data Registry database, do not account for physicians using VCDs only when femoral access is uncomplicated, femoral arteries appear healthy, and groin appearance at the end of the case looks optimal. Otherwise, operators have tended to select manual compression, such as when there is a hematoma forming, and there is a strong (and wise) predisposition to avoiding VCDs when the femoral artery is diseased, calcified, or small or when the puncture site is high or low. Thus, studies that compare outcomes based on registries have a nearly universal flaw—the inability to account for a deck that is inadvertently stacked by selection bias in favor of VCDs. Propensity analyses that favor VCD use have the problem that it is nearly impossible to account for factors that are only addressable by high-level, randomized controlled trials, and the latter have simply not existed in the VCD literature.

Despite this, I believe that VCDs can lower complication rates, as long as certain caveats are appreciated. First, using VCDs to improve safety is a class III indication per an American Heart Association scientific statement,[6] an unnecessarily harsh assessment in my opinion, but one that is based on the lack of a solid evidence base. It would be negligent not to mention this, given the medicolegal implications implied. Second, there is absolute certainty that in any comparison between radial access, femoral access using manual compression, and femoral access with VCD use, certain complications are unique to the third group.

Table 1 outlines an attempt to highlight the strengths and weaknesses of these three approaches. Infection, albeit rare (~0.25%), is almost invariably associated with VCDs, as are clinically important vascular obstruction and retroperitoneal hemorrhage (RPH); the latter is uncommon but not rare (~0.5%), and in some reports has been 10-fold more likely to occur after VCD deployment than with manual compression. Why VCD use is associated with RPH, wheth-

TABLE 1. COMPARISON OF ADVANTAGES AND DISADVANTAGES OF RADIAL VERSUS FEMORAL ACCESS WITH OR WITHOUT VCD USE*

	Radial Access	Femoral Access With Manual Compression	Femoral Access With VCD Use
Learning curve			
Ease of access			
Puncture			
Maneuver to coronary artery			
Likelihood of crossover			
Image quality			
Backup support			
Size flexibility			
Complications			
Hematoma			
RPH			
Infection			
Ischemic limb†			
Time			
Procedure			
To ambulation			
Radiation			
Comfort			
Cost			

Note: Green = superior; red = inferior; yellow = intermediate; white = not applicable.
Abbreviations: RPH, retroperitoneal hemorrhage; VCD, vascular closure device.
*This comparison assumes operators are, at most, moderately experienced. Not every category has a clear demarcation. Many of the comparisons are devoid of high-level evidence base and/or reflect the biases/observations of the author.
†Although ischemic limb due to vascular obstruction is rare with radial access, compartment syndrome does occur, and asymptomatic vascular obstruction is relatively frequent and most likely to occur with the radial approach.

TECHNIQUES TO OPTIMIZE FEMORAL PUNCTURE

- Micropuncture
- Fluoroscopic guidance with iterative fluoroscopy and/or ultrasound guidance
- Fluoroscopy of needle wire interface prior to sheath placement to confirm puncture location at or below the centerline of the femoral head (desirable location in most cases)
- Fluoroscopy of guidewire advancement prior to withdrawing the needle and placing sheath to confirm that the wire is in the external iliac artery (and not the inferior epigastric or lateral circumflex of the hip or other branch arteries) (Figure 2)
- Use the smallest sheath appropriate for the procedure
- Femoral angiography at the beginning (not the end) of the case, preferably with a wire in the sheath to protect the vessel at the distal tip*
- In case of failed or bad access,† hemostasis followed by repuncture
- Avoidance of anticoagulation and procedures requiring anticoagulation if the puncture site appears to be above the inguinal ligament (diagnostic catheterization without anticoagulation may still be acceptable if a sheath is already in place)

*An alternative to sheath fluoroscopy is angiography through a micropuncture dilator.
†*Bad access* is defined as puncture that is high or low, into a severely diseased segment, or into an artery too small for the sheath size required.

er this is a class effect or distinct to various VCDs, and how to avoid it were previously discussed in an article in *Endovascular Today*.[7] RPH does occur with radial access; however, it is spontaneous unless the iliac circulation is accessed via the radial approach. Thus, for VCD use to demonstrate equipoise with radial access, the advantages of VCDs must overcome a significant handicap inherent in their use at the time of deployment.

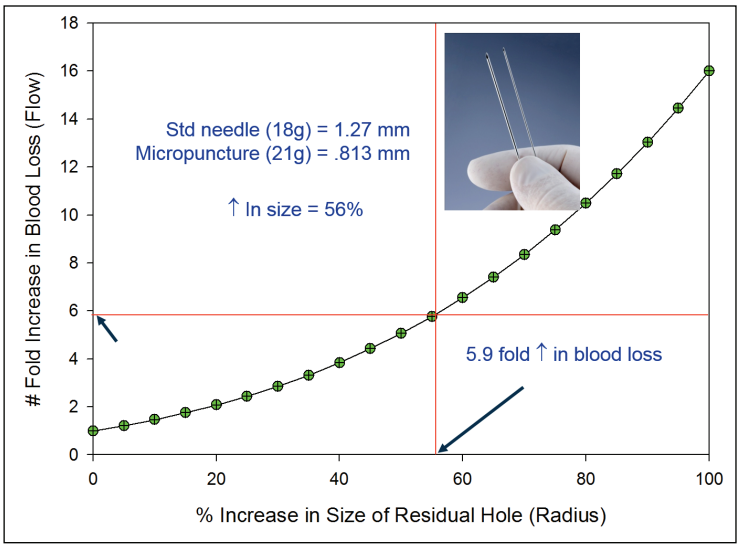

Figure 1. The case for micropuncture. It is important to consider the relationship between the size of the needle and blood flow. A standard 18-gauge needle is approximately 58% larger than a micropuncture needle. Applying Poiseuille's law (the resistance to flow is inversely proportional to the fourth power of the radius) and Ohm's law (flow is inversely proportional to the resistance), the rate of blood loss from uncontrolled puncture with an access needle is nearly six times greater when an 18-gauge needle is used. Adapted from Turi ZG. Overview of vascular closure. Endovasc Today. 2009;8:24-32.

LIMITATIONS OF RADIAL ACCESS AND OPTIMAL FEMORAL TECHNIQUE

It is impossible to show that radial access is equivalent to femoral access plus VCD use unless we accept some unique limitations to radial access and minimize the complications associated with both femoral access as well as VCD use. An argument can be made that we should be considering not only complications, but other limitations and strengths of these techniques as well, which are outlined in Table 1.

A point that I have frequently made is that the number one reason that radial versus femoral studies show a disparity in favor of the radial technique is underutilization of optimal techniques for femoral access (although I acknowledge that there are other compelling advantages of radial access as well).[8] Excellent femoral access is the key to outcomes, and unfortunately, many operators and sites still do not use optimal access techniques. Educational initiatives have resulted in substantially greater adoption of the techniques (see the *Techniques to Optimize Femoral Puncture* sidebar). The propensity analysis that has most elegantly demonstrated superior outcomes with VCD use versus manual compression is by Arora and colleagues from the Brigham and Women's Hospital,[9] an institution that rigorously adopted the techniques propounded in both *Endovascular Today* and *Cardiac Interventions Today* for more than a decade.

Two elements described in the *Techniques to Optimize Femoral Puncture* sidebar are worthy of specific mention in this discussion. First, micropuncture involves the use of a needle that is typically 38% smaller in diameter than a regular 18-gauge needle; if there is an errant stick with the latter, the potential flow rate through the hole created in an artery is up to 5.9 times greater than with an errant micropuncture (Figure 1). The operator needs to be aware that micropuncture wires travel readily into side branches that can be perforated if a sheath is advanced over them, as well as myriad other "tricks of the trade," without which the technique can actually compromise safety (Figure 2). That randomized trials[10] have failed to demonstrate the superiority of micropuncture is related to the difficulty of designing a study to show this and not to the concept that a smaller hole is inherently safer. I use micropuncture for virtually all vascular access (venous and arterial) as well as pericardial entry.

Second, image-guided femoral access is a greater boon to safety than any incorporation of VCDs is likely to be. We have preached adoption of universal fluoroscopy, using an iterative technique, but the value of ultrasound-guided access should not be underestimated. The FAUST trial demonstrated the superiority of ultrasound over fluoroscopy, although one could argue that the fluoroscopic technique used a single fluoroscopic image versus the iterative technique, which handicapped the study in favor of ultrasound. In addition, 28% of ultrasound-guided punctures were over the top third of the femoral head, and 11% were above the femoral head, pointing to the benefits of ultrasound to avoid low sticks (as well as many other advantages) but highlighting its failure to avoid high sticks. Unfortunately, the latter are arguably far more dangerous because of the strong relationship between high sticks and RPH.

By way of disclosure, I perform virtually all coronary procedures via the radial approach. However, the vast majority of my work in the past decade has been structural interventions, and I continue to use femoral access for most of those cases. I have adopted the practice of

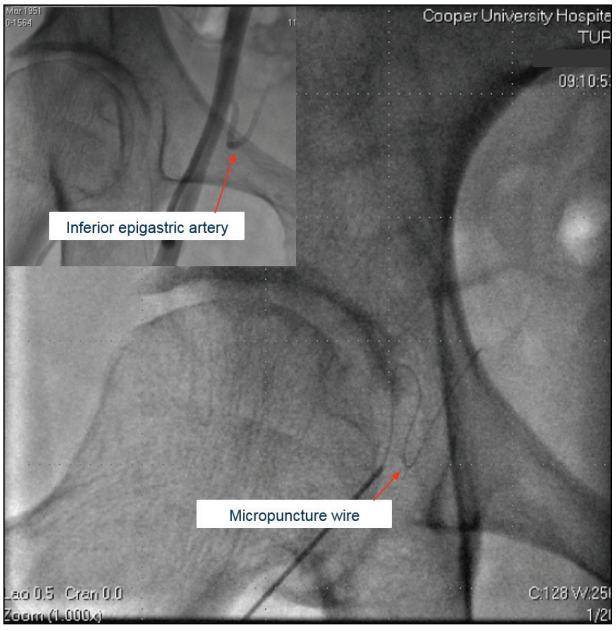

Figure 2. The case for fluoroscopy of the wire prior to sheath advancement. The micropuncture wire has been advanced and does not appear to follow the standard path of the external iliac artery. The wire was withdrawn and readvanced, a sheath was placed, and contrast was then injected (upper left inset). As clearly shown, the wire had been in the inferior epigastric artery. Sheath advancement would almost certainly have led to perforation and probably retroperitoneal hemorrhage.

routine ultrasound-guided access and urge operators (who have not considered this) and labs (that have not acquired the necessary equipment, expertise, and training) to consider fully adopting ultrasound guidance, especially for large-bore access. Comfort with and knowledge of the subtleties involved in large-bore access and closure, primarily for the "preclosure" technique, are essential for safely negotiating percutaneous entry and exit with large-bore devices.

THE BOTTOM LINE

As highlighted in Table 1, each approach (radial, femoral, and femoral with VCD use) has strengths as well as weaknesses. I acknowledge that some of the choices in Table 1 are controversial. Experienced radialists will appropriately argue that time to access and radiation are not significantly worse in highly experienced hands. Similarly manipulating catheters to the coronary ostia is much faster and more efficient if performed by high-volume radial operators. Femoral access has a shorter learning curve and is associated with easier catheter manipulation and lower likelihood of crossover. Typically, image quality and backup support are better with the femoral approach (again highly experienced radialists have multiple ways to address these issues, although it does require additional experience and effort), and size flexibility is clearly an advantage for the femoral approach.[8]

VCDs address a few of the drawbacks of the femoral approach, but do not swing the scale back to neutral. VCDs enhance patient comfort and speed ambulation; the additional costs of VCDs are at least partly offset for outpatients who can be discharged earlier, since early ambulation and decreased cost correlate strongly overall. However, infection, vascular occlusion with limb ischemia, and RPH occur disproportionately with VCD use. Thus, in the hands of highly experienced operators, the radial approach strikes me as the clear winner overall, with reduction of complications being the most important advantage.

Nevertheless, competence at femoral access remains essential. As laboratories, in particular academic programs, convert to primarily radial access, it is vital that graduating fellows be well trained in a large enough number of femoral cases. Otherwise, without knowing the nuances of the femoral approach, cases that crossover or sick patients who require large circulatory support devices will see a substantial and disproportionate complication rate. ■

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