

# Inadvertent Innominate Artery Puncture Repair

Using the StarClose vascular closure device to repair the unintended placement of a dual-lumen catheter without surgery.

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**I**nadvertent arterial puncture is one of the most common complications during placement of a central venous catheter (CVC). In this article, we describe a novel application of a commercially available vascular closure device (VCD) in the management of an inadvertently placed dual-lumen CVC in the innominate artery.

## CASE REPORT

An 87-year-old woman with a medical history of hyperlipidemia, osteoarthritis, and hypertension presented for surgical excision of a large right posterior gluteal sarcoma. Central venous line placement via the right subclavian vein was attempted in the operating room, resulting in the inadvertent placement of a 4-F dual-lumen catheter in what, at that time, was believed to be the subclavian artery (SA). Because of our concern about the inability to externally compress the SA, a decision was made to bring the patient to the angiography suite to

better assess the exact location of the puncture site, manage it via catheter-based techniques, and avoid an operative solution for catheter removal.

Initially, a retrograde injection was made via the dual-lumen catheter (Figure 1). This revealed significant tortuosity of the SA and catheter placement in the distal innominate artery (IA). The right femoral artery was accessed next, and a pigtail catheter was placed in the ascending aorta. A left anterior oblique projection confirmed dual-lumen catheter placement in the IA (Figure 2).

The patient was systemically anticoagulated, and a JB2 catheter was used to gain access into the IA. A stiff guidewire was then advanced into the right external carotid artery. Initially, placement of a covered stent was contemplated. However, because of the close proximity of the puncture site to the IA bifurcation and concern for the possibility of occluding either the common carotid artery or the SA, we decided against this option. Instead,

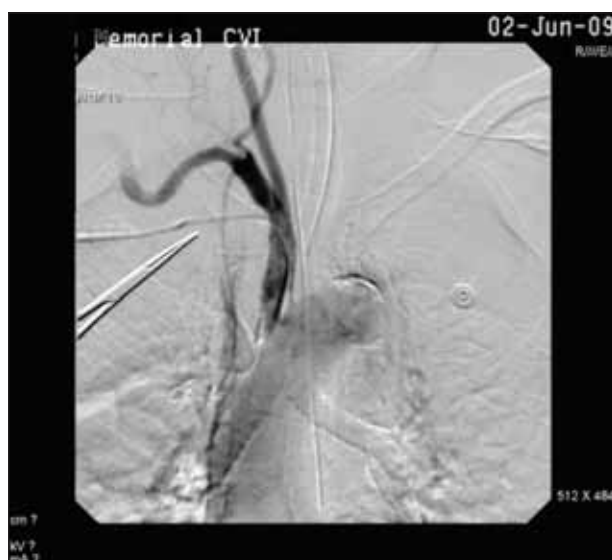


Figure 1. Initial angiogram revealed inadvertent placement of the dual-lumen catheter in the IA.



Figure 2. Arch angiogram confirmed placement of the dual-lumen catheter in the IA.

a decision was made to attempt closure using a Star Close VCD (Abbott Vascular, Santa Clara, CA). We had already established wire access to this area in case of failure of this device.

Another stiff guidewire was advanced through the dual-lumen catheter well into the IA. The dual-lumen catheter was removed, and the VCD device sheath/dilator assembly was advanced over the guidewire into the IA. The dilator and guidewire were removed, and the closure device was advanced through the sheath and deployed in the usual fashion. Repeat angiography revealed an excellent seal without evidence of extravasation (Figure 3). The patient was transferred to the surgical intensive care unit in stable condition.

## DISCUSSION

In 1952, Sven-Ivar Seldinger developed an innovative technique for the percutaneous insertion of large-bore catheters into blood vessels. Placement of a CVC is an essential skill practiced by physicians in all aspects of medicine, as well as nurse practitioners and physician assistants. These individuals possess significantly varying training and experiences. These procedures take place in a variety of settings (eg, operating room, bedside, emergency department, intensive care unit, etc.).

The annual number of all CVC insertions in the United States is not known but is estimated to be in the range of several million.<sup>1</sup> Unsuccessful insertion of CVCs may occur in up to 20% of cases.<sup>1-3</sup> In general, the rate of major and minor complications is between 0.5% and 10%. Although these catheters can be lifesaving, they are also associated with significant risks. These risks increase in association with several characteristics, including patient anatomy, setting, and comorbidities.<sup>4</sup>

Percutaneous insertion of CVCs has traditionally been performed by “blind” techniques that rely on anatomic landmarks.<sup>4</sup> Inadvertent arterial puncture, hematoma, and pneumothorax are the most common mechanical complications during insertion of a CVC.<sup>5</sup>

There has been extensive debate regarding ultrasound guidance for the placement of CVCs. Newer technologies, such as portable ultrasound devices, provide bedside imaging with potential advantages that include detection of anatomic variations and exact vessel location, avoidance of veins with pre-existing thrombosis, and a reduced number of attempts at cannulation.<sup>4</sup> The Society of Interventional Radiology Standard of Practice Committee defines image-guided percutaneous central venous access as the placement of a catheter with its tip in the cavoatrial region with the assistance of real-time imaging, most commonly fluoroscopy and/or ultrasonography.<sup>6</sup> Using these imaging modalities, an overall major complication



**Figure 3.** Angiogram after closure device deployment reveals no evidence of extravasation (StarClose device depicted by red arrow).

rate of approximately 3% can be expected.

A meta-analysis of the literature estimated that real-time ultrasound guidance for CVC insertion in a variety of anatomical locations is associated with a significant reduction in placement failure compared with the usual landmark techniques.<sup>7</sup> In addition, this review estimated that ultrasound guidance results in decreased complications during CVC placement, with a relative risk reduction of 78%. The mean number of venipunctures until successful insertion was significantly reduced, with a relative risk reduction of 40%.

A randomized controlled study compared the landmark and ultrasound-guided techniques specifically used for infraclavicular subclavian vein catheter placement.<sup>8</sup> The ultrasound-guided group had a significantly higher success rate, lower complication rate, and fewer venipunctures before access was achieved, all of which were statistically significant. In addition, 80% of failed landmark-guided attempts were salvaged by the use of ultrasound. Of particular interest in this case report is that inadvertent arterial puncture in the SA can occur in up to 5% of patients during CVC placement in the subclavian vein, possibly leading to excessive bleeding requiring a blood transfusion and/or surgery. The morbidity associated with surgical repair of the SA could be substantial.

We believe that in this case, two factors contributed to the injury to the SA. First, the entry site was too far below the clavicle. Second, as seen in the initial angiogram, the SA appears extremely tortuous and takes an unusual course, which may have contributed to the needle missing it.

There are no definitive guidelines on the management

of accidental arterial cannulation during CVC placement. However, immediate catheter removal and attempts at a compression technique, particularly with catheters that are 7 F or larger, are associated with a significant risk of complications such as expanding hematoma, airway compromise, stroke, pseudoaneurysm formation, and even death.<sup>9</sup>

Techniques such as percutaneous deployment of covered stents and balloon tamponade techniques have been used to treat a variety of arterial complications. In addition, a variety of methods, such as direct manual compression, sandbags, and mechanical clamps, have been used to achieve hemostasis after transfemoral diagnostic and therapeutic coronary and peripheral arterial interventions. Many of these methods have proven less than satisfactory, causing patients significant discomfort and requiring up to several hours of bed rest. A variety of VCDs are commercially available for percutaneous closure of femoral artery puncture sites after these procedures.

These devices provide reliable hemostasis as an alternative to manual compression. They are a simple, painless, and reliable closure method and have been proven effective after endovascular procedures that have been performed transfemorally. Enhancement of patient comfort, shortened time to ambulation, and decreased reliance on expensive catheterization laboratory resources have resulted from the incorporation of VCDs into common practice. As of early 2009, there were five VCDs that represented the majority of the closure devices sold.<sup>10</sup> VCD sales are widely believed to range between \$500 and \$700 million annually and continue to rise. In addition to the large variety of these devices that are currently available worldwide, there are at least another half dozen VCDs making their way through testing.

The StarClose VCD was approved in December 2005 and uses a flexible nitinol clip to complete a circumferential, extravascular arteriotomy closure. The mechanism of action is centered on deployment of four flexible wings, which when released from the clip applicator, grasp the edges of the vascular tissue and draw the tissue together to create closure of the arteriotomy site. The StarClose device has a success rate of 97% associated with its use in the femoral artery after heart catheterization.<sup>11</sup> Benefits of the device include rapid hemostasis without the need for anticoagulant reversal, as well as significantly less time to ambulation than manual compression.

StarClose has been used successfully for closing femoral artery catheterization sites. However, to date, we have not located a reference citing the use of the StarClose device to close other vessels, outside of a reference to closure of the brachial artery after a percutaneous endovascular procedure<sup>12</sup> and for closure of the SA after inadvertent placement of a 7-F triple-lumen catheter.<sup>13</sup> A variety of other VCDs (Angio-Seal [St. Jude Medical, St. Paul, MN] and

Perclose [Abbott Vascular]) have been successfully used to manage inadvertent arterial injuries. In this case, the StarClose device was successfully used to manage an inadvertent puncture of the IA with a dual-lumen catheter. A surgical approach to this problem would surely have been associated with significant morbidity in this elderly patient.

## CONCLUSION

This patient's presentation provided a novel opportunity for application of the StarClose VCD, permitting rapid closure of the catheter access point while showing the efficacy of the intervention and the merits of including minimally invasive and alternative interventions in the list of the available therapies when indicated or possible. Benefits of its implementation in this particular case were rapid, minimally invasive hemostasis, absent subsequent bleeding from the catheter site, and the opportunity to forego the significant morbidity associated with open surgical intervention. ■

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