Percutaneous access of the superior vena cava in patients with bilateral jugular-subclavian vein occlusion using wire-target access for placement of tunneled hemodialysis catheters: An important new tool for gaining upper body vascular access

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ABSTRACT
This study presents the technique of percutaneous wire-target access of the superior vena cava (SVC) in patients with bilateral jugular-subclavian vein occlusion requiring a tunneled hemodialysis catheter. A 3-year retrospective review of five patients was performed. The femoral vein is accessed percutaneously and a 5F sheath inserted. This is followed by placement of a pigtail catheter (wire-target) in the SVC with cavography. The SVC is percutaneously cannulated at the level of the pigtail under fluoroscopy, and a guidewire is passed into the vena cava with confirmation by injection of contrast material. A tunneled hemodialysis catheter is then placed. The wire-target technique of SVC access can be used safely and effectively to establish upper body catheter access when traditional techniques are not possible. (J Vasc Surg Cases and Innovative Techniques 2020;6:156-9.)

Keywords: Wire-target access; Bilateral jugular-subclavian vein occlusion

The prevalence of chronic kidney disease in the United States has doubled since 1990.1 Currently, 1 million patients have end-stage renal disease; the majority require dialysis treatment, resulting in an increase in referrals for placement of tunneled dialysis catheters (TDCs) for temporary dialysis access.1

The internal jugular vein is the initial choice of vascular access for placement of TDCs. However, many patients require multiple lines during the course of their dialysis treatment, resulting in central venous stenosis and thrombosis, which limits access options. A second option for venous access is the femoral vein.2,3 Multiple reports have shown that femoral TDCs are inferior to internal jugular vein catheters in both the rate of primary patency and the risk of catheter-related infection.2,3

The wire-target technique is an innovative approach for obtaining upper body central vascular access in the presence of jugular and subclavian vein occlusion when standard percutaneous central vascular access is not possible. It has been described in gaining central vascular access in challenging pediatric patients with complex cardiovascular anatomy.4

This article describes our application of the wire-target access technique in accessing the superior vena cava (SVC) in patients with bilateral jugular-subclavian vein occlusion. This report is the first description of its use in adults needing central vascular access for hemodialysis catheter placement. This avoids the placement of femoral dialysis catheters with their attendant morbidity and discomfort. All patients gave their permission to publish their case details and images.

METHODS
A retrospective review was conducted of patients who underwent TDC placement using wire-target SVC access at a tertiary referral center from January 2016 to May 2019. All procedures were performed by a vascular surgeon in a hybrid operating room. Five patients were reviewed. Data including demographics, preoperative diagnostic imaging, and 30-day complications were collected.

Procedural description and technical tips. Before the procedure, preoperative imaging, including venograms obtained during previous TDC placement, duplex ultrasound imaging, and computed tomography angiography studies, was reviewed. In all of the cases, occlusion of both bilateral internal jugular and subclavian veins was noted, making upper body central venous access by the standard percutaneous ultrasound-guided technique not an option.

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All of the procedures were performed under conscious sedation in the hybrid operating room. The right or left femoral vein was accessed percutaneously using the modified Seldinger technique and a 5F sheath placed. Through the 5F sheath, a pigtail catheter was advanced fluoroscopically over a 260-cm-long Glidewire (Terumo Interventional Systems, Somerset, NJ) into the patent extrapericardial SVC to the point of jugular-subclavian vein obstruction (just beneath the clavicle and lateral to the manubrium). Superior venacavography was then performed (Fig 1). By use of the pigtail location as the guide (wire-target), the SVC was percutaneously cannulated at the level of the pigtail catheter through a rightsided supraclavicular puncture approach (5-mL slip tip syringe with standard 18-gauge 7-cm [2.75-inch]-long access needle) at the apex of the triangle bordered by the lateral head of the sternomastoid muscle with the medial head of the clavicle (Fig 2). Real-time anteroposterior fluoroscopy was required while maintaining suction on the needle. With venous blood return in the syringe, SVC access was confirmed by injection of contrast material, followed by 0.035-inch guidewire passage (Fig 3) and then TDC placement through a peel-away sheath into the right side of the heart (Fig 4). The pigtail catheter was removed, followed by removal of the femoral venous sheath.

RESULTS
A total of five patients underwent right-sided TDC placement by wire-target access of the SVC during the study period. Characteristics of the patients who underwent wire-target access technique are shown in the Table. The mean age was 58.6 years. There were three women and two men. All of the patients had occluded bilateral internal jugular and subclavian veins documented preoperatively. All of the TDCs remained patent, and no procedure-related complications including pneumothorax, bleeding, or inadequate dialysis flow were noted during 30-day follow-up.

DISCUSSION
Our experience with the wire-target access technique for upper TDC placement in the setting of bilateral upper extremity venous occlusion demonstrated that it is a viable and safe alternative when standard approaches are not possible or usable. Our series had 100% success rate in establishing vascular access and subsequent placement of a TDC in the SVC. Most important, no procedure-related complications were observed.

There are limitations to our series. With the SVC being located in the right superior mediastinum, only rightsided supraclavicular puncture was used for access, although it may be possible to do so from the left side. Only real-time anteroposterior fluoroscopy was required
for access in our cases, but depending on the patient’s anatomy, anterior oblique or lateral fluoroscopy may be needed. We did not observe any procedure-related complication; however, this may be due to the small sample size of our study.

One specific limitation of the wire-target access technique compared with the standard technique is that it also requires temporary femoral venous access. It is possible that this may introduce additional morbidity, such as groin hematoma or infection and puncture site pain, although this is probably outweighed by avoidance of the alternative—indwelling chronic femoral venous catheter.

The SVC consists of extrapericardial and intrapericardial segments, with the extrapericardial segment being contiguous with the brachiocephalic veins. The fusion of the fibrous and serous pericardium at the transverse sinus separates these two segments and isolates the extrapericardial segment from the pericardial sac.7

Percutaneous access of the SVC by wire-target access in patients with bilateral jugular-subclavian vein occlusion is possible because of the anatomic location of the central veins and the extrapericardial portion of the SVC in the superior mediastinum; they are anterior and superior to the great vessels and the aortic arch, which are inferior and posterior (Fig 5). With occlusion of the jugular and subclavian veins caused by the need for repeated TDC placement, the thrombotic process usually extends into the brachiocephalic veins (because of lack of venous collateral filling), with patency of the extrapericardial SVC being maintained by the azygos vein and the smaller superior mediastinal collateral veins. In addition, the perivenous fibrosis that occurs with central venous occlusion usually extends into the brachiocephalic veins and serves as a fibrous tract (highway) that can be penetrated safely with a large-bore access needle until blood is returned from the extrapericardial SVC.

As experience and comfort with the technique of percutaneous access of the extrapericardial SVC accrue and its safety and reliability are established, it will give surgeons an important new additional tool for the treatment of the growing number of complex vascular access patients, thereby avoiding chronic femoral venous cannulation and its attendant morbidity and mortality. Although we have not used this technology for placement of the HeRO device (Hemodialysis Reliable Outflow; Merit Medical, South Jordan, Utah), it is easy to see how this could be done.

| Table. Basic characteristics of patients |
|-------------------------------------|-----------------|
| Age, years, mean (range)           | 58.6 (41-78)   |
| Sex                                 |                |
| Male                                | 2              |
| Female                              | 3              |
| Complications                       |                |
| Pneumothorax                        | 0              |
| Bleeding                            | 0              |
| Inadequate dialysis                 | 0              |
Other treatment options that are and have been used for upper body access placement in the setting of central venous obstruction include surgical bypass with spiral vein, angioplasty, and stent placement and inside-out vascular access with HeRO device placement. Results of central venous angioplasty with or without (mostly) stent placement have been disappointingly poor in the numerous reported series since its introduction many years ago. Surgical bypass has limited application because of its need for median sternotomy. Inside-out vascular access technology (Surfacr, Merit Medical) is currently in clinical trials in the United States and is not approved for general use, although it has gained CE Mark, and results from a small European study demonstrating its efficacy have been published.8

CONCLUSIONS

TDC placement in the right side of the heart in adults with bilateral upper extremity central venous occlusion can be challenging. The wire-target SVC access technique is a simple, safe, and effective percutaneous alternative for obtaining upper body central vascular access using standard real-time fluoroscopic interventional techniques in these patients with difficulty in access.

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