Management with right atrium to jugular and brachiocephalic vein bypass for dialysis catheter-related superior vena cava syndrome

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ABSTRACT

Superior vena cava (SVC) syndrome is a spectrum of potentially life-threatening clinical manifestations resulting from either partial or complete obstruction of central venous blood flow. Approximately 70% of cases are caused by malignancy. The primary treatment end point for SVC syndrome is the achievement of long-term patency of the SVC. Malignant SVC syndrome is managed by either radiation therapy, open surgical intervention, or endovascular therapy with angioplasty and stenting. The current report describes an uncommon case of nonmalignant SVC syndrome resulting from complications of hemodialysis catheters that was managed with open revascularization between the right internal jugular and brachiocephalic veins and the right atrium. (J Vasc Surg Cases Innov Tech 2023;9:101306.)

Keywords: Atrium to jugular and brachiocephalic vein bypass; Central vein occlusion

Symptomatic superior vena cava (SVC) syndrome typically manifests as swelling involving the head, neck, and upper extremities. Approximately 70% of cases of SVC syndrome are caused by malignancy.[1,2] Benign causes of SVC syndrome account for the remaining 30% of cases, with most due complications of central venous catheters and implantable cardiac devices.[1] The present patient provided written informed consent for the report of his clinical care details and imaging studies.

CASE REPORT

The patient is a 47-year-old African-American man with a history of end-stage renal disease (ESRD) requiring peritoneal dialysis since 2015. He was referred to our practice for a 1-month history of worsening facial and bilateral upper extremity swelling, with the left side greater than the right. His renal failure is secondary to uncontrolled hypertension. His medical history is also significant for human immunodeficiency virus disease, multiple upper body tunneled dialysis catheters, and multiple failed upper extremity arteriovenous hemodialysis (HD) access attempts. When he presented 6 months prior with severe left upper extremity venous hypertension, he underwent ligation of a patent, but obsolete, left upper arm arteriovenous fistula, because he was no longer undergoing HD. He had initial improvement in symptoms until the current presentation with rapidly escalating SVC syndrome symptoms. Computed tomography angiography and computed tomography venography (CTV) demonstrated high-grade stenosis of the right subclavian vein with collateral flow about the right chest. The right brachiocephalic vein was occluded. In addition, high-grade stenosis of the SVC and left brachiocephalic vein were present. Based on the CTV, the patient was brought in for catheter-based venography, which more clearly demonstrated the distribution of occluded central veins and the inaccuracy of CTV findings in this setting (Fig 1).

Percutaneous sharp recanalization of the SVC was planned but was not possible owing to the large gap between the stump of the SVC and the brachiocephalic veins (Fig 1). After the aborted percutaneous attempt to resolve the SVC syndrome, the patient was left intubated owing to his rapidly progressive symptoms. A femoral tunneled HD catheter was placed to accomplish more effective dialysis and hemofiltration and improve his symptoms for future open surgical reconstruction of his SVC. Two weeks later, he underwent open SVC reconstruction comprising median sternotomy and right atrium to right internal jugular vein and brachiocephalic vein bypass (Fig 2) using a 20 × 10 Gore-Tex graft (W.L. Gore & Associates) performed by vascular and cardiothoracic surgeons. Although significant venous congestion of the mediastinum was anticipated, only a few subcutaneous varicosities were encountered that were easily controlled with standard hemostatic techniques. This was also reflected by the fairly low blood loss during the case of 350 mL. Careful attention must be given to avoiding graft compression during sternal closures similar to grafts coming off the ascending aorta for arch debranching procedures. In the present case, the key to positioning the graft appropriately included originating the graft off the lateral atrium and tunneling the limbs as deep in the mediastinum as possible (Fig 2).

The patient tolerated the procedure, had an uneventful postoperative recovery, and was discharged home on the fifth hospital day. He was maintained on catheter-based HD for a few weeks into recovery and then was transitioned back to peritoneal dialysis and had his tunneled catheter removed. The patient had complete resolution of his facial and upper extremity edema at his first postoperative follow-up appointment (Fig 3). He has continued to take apixaban since the procedure and has remained free of any recurrent symptoms of SVC obstruction for 14 months. Although no specific data are

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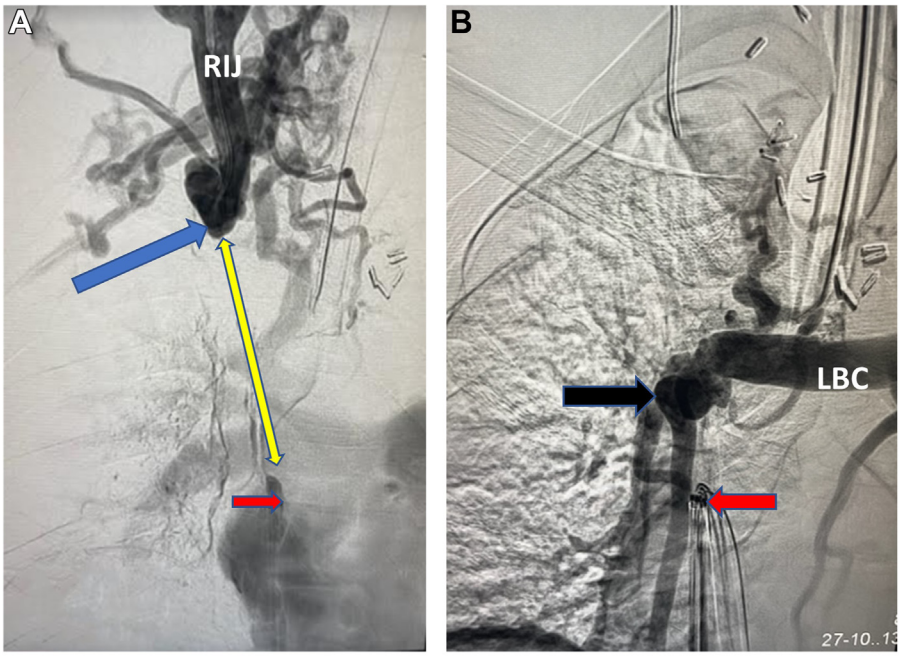

Fig 1. Venogram demonstrating the anatomy of the upper body central veins. **A,** Injection from the catheter in right internal jugular (*RIJ*) vein demonstrating occlusion of the right brachiocephalic vein (*blue arrow*) with a mediastinal collateral vessel with the sheath tip in the right atrium at the stump of the occluded superior vena cava (SVC; *red bar*). Distance between the stump of the SVC and RIJ vein was 8 cm (*yellow arrow*). **B,** Injection from left arm venous catheter demonstrating patent left brachiocephalic vein flowing into the azygous vein (*black arrow*) with no direct communication to the right atrium catheter tip (*red arrow*).

available, to the best of our knowledge, addressing specific patients undergoing SVC reconstruction, we chose to treat him similar to other patients with central venous pathology and venous grafts.

DISCUSSION

In this case report, we describe successful SVC reconstruction in an ESRD patient with HD access complicated by significant central venous occlusion involving the SVC and bilateral brachiocephalic confluence. SVC syndrome was first described by William Hunter[3] in 1757 secondary to a compressive syphilitic aortic aneurysm. The literature has since established direct infiltration vs compression by malignancy as the predominant cause of SVC syndrome, although with the emergence of central venous devices, ≤30% of all cases have been attributed to their increasing usage.[1]

In ESRD patients, the introduction of a central venous catheter causes direct vessel injury, which predisposes the SVC to stenosis, thrombosis, and, ultimately, occlusion. This risk is observed to be greater in patients with suboptimal catheter size and/or placement.[4,5] Eventually, SVC syndrome will manifest as a range of clinical features, including facial plethora, upper body and arm swelling, cough, dyspnea, stridor, chest pain, orthopnea, cyanosis, papilledema, and altered mental status.[6,7] Patients with HD-related SVC syndrome generally have a slower onset of symptoms compared with those with malignancy; thus, the prevalence of SVC syndrome in HD patients might be underestimated. Moreover, Siegel and Kukuer[8] reported HD-dependent patients have an elevated risk of complete SVC obstruction compared with those with chest neoplasm.

The diagnosis of SVC syndrome often requires multiple imaging modalities. Computed tomography angiography can be useful in defining the area of SVC stenosis vs occlusion. Contrast-enhanced venography should be used to confirm the level and degree of obstruction and can allow for concurrent endovascular therapy with balloon angioplasty and stenting if the obstruction can be crossed with a guidewire using traditional catheters or sharp recanalization techniques. Most cases of nonmalignant SVC syndrome can be initially treated with endovascular therapy. The anatomy of our patient's central venous occlusive disease precluded endovascular treatment owing to the large gap between the occluded brachiocephalic venous branches and the residual SVC stump in the right atrium (Fig 1).

An endovascular-first approach for SVC syndrome provides rapid symptom relief and does not exclude or affect the outcome for potential revision to open surgical repair, making it a reasonable primary intervention for appropriate patients.[9,10] Nevertheless, this strategy frequently requires reintervention to achieve a desired

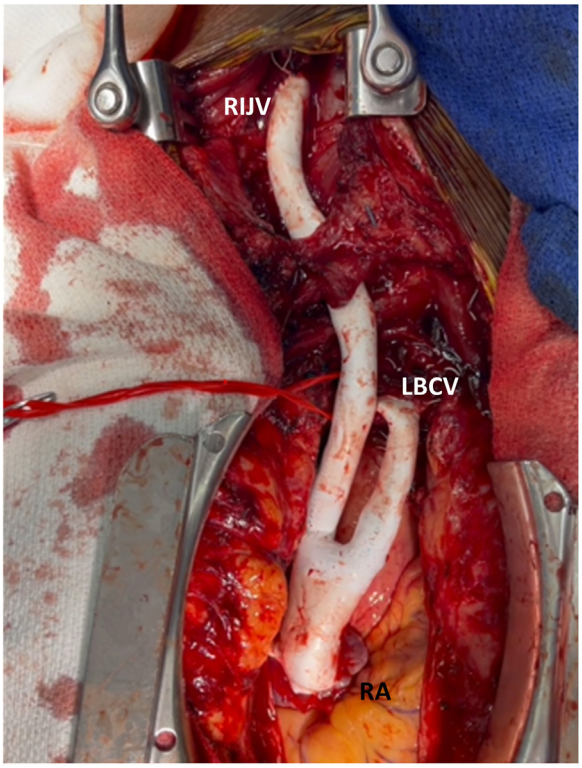

Fig 2. Median sternotomy approach for bifurcated bypass between the right atrium (*RA*) with limbs to the right internal jugular vein (*RIJV*) and left brachiocephalic vein (*LBCV*).

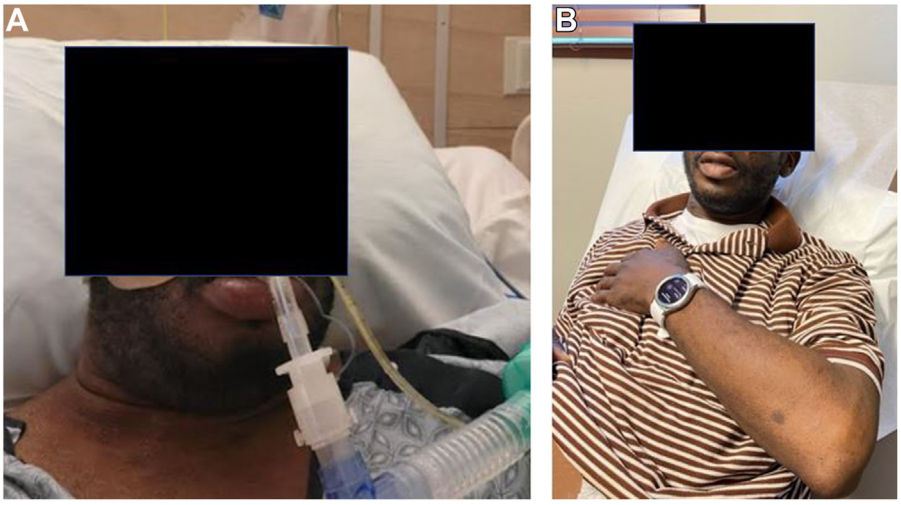

Fig 3. A, Photograph of patient after aborted attempt at percutaneous sharp recanalization of the superior vena cava (SVC) showing massive facial edema. **B,** Photograph of patient 3 weeks after SVC revascularization demonstrating complete resolution of symptoms of SVC syndrome.

effectiveness end point, and even then, the symptom relief is often temporary.[9,11] Angioplasty alone has poor long-term patency rates, with the literature citing the higher recoil attribute of central veins compared with peripheral veins as a major source of treatment failure.[12] Bare metal stents are also shown to have variable immediate- and long-term patency necessitating frequent reintervention.[13] Although covered stents have performed better than their bare metal counterparts, the literature also describes a high reintervention rate for cases of significant central venous occlusion.[14] Novel percutaneous approaches to sharp recanalization of occluded right brachiocephalic veins using the Surfacer system (Merit Medical), as recently described by Gallieni

et al,[15] might permit endovascular treatment for some of the patients with more complicated central vein occlusion.

A comparative study of endovascular vs open repair for SVC syndrome revealed comparable short- and mid-term flow patency results but superior long-term outcomes for open repair.[11] Various grafts for SVC reconstruction are described in the literature.[16] The ideal graft or conduit system should have a nonthrombotic surface, maintain long-term flow patency, and exhibit durability against external compression. Synthetic grafts remain an attractive option with their range of sizes, ready availability, and, with modern technology, the ability to be uniquely designed for a specific individual's anatomy.

The most current report from the U.S. Renal Data System suggests ESRD patients have a longer life expectancy; however, with this, comes a longer period of HD dependence and a projected increase for those who will develop complications, including SVC syndrome.[17] Limited long-term outcome data are available at present regarding open SVC reconstruction for HD-dependent patients. Paik et al[18] recently reported the first systematic review of 55 dialysis patients who underwent right atrial bypass grafting for central venous occlusion. They reported a 30-day mortality of 4% after right atrial bypass construction. The rate of postoperative complications, including surgical site infection, hemorrhage, and early access site thrombosis, was 0%, 4%, and 4%, respectively.

In this case report, we describe successful SVC reconstruction using a bifurcated graft to anastomose the left brachiocephalic and right internal jugular veins to the right atrium in a patient whose anatomy was prohibitive for endovascular therapy. Given that the incidence of HD-related SVC occlusion is expected to rise owing to the high incidence of patients requiring dialysis exposed to tunneled catheters, open surgical therapy for dialysis catheter-related SVC syndrome should be a part of the armamentarium for physicians who manage complications of HD access.

DISCLOSURES

None.

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