Radiofrequency wire technique and image fusion in the creation of an endovascular bypass to treat chronic central venous occlusion

Ricardo Yamada, MD, Beatriz Bassaco, MPH, Clark Wise, BS, Laura Barnes, MD, Nima Golchin, MD, *and* Marcelo Guimaraes, MD, FSIR, *Charleston, SC*

ABSTRACT

The goal of this case report was to demonstrate the feasibility, safety, and efficacy of image fusion software to treat symptomatic central venous occlusion with radiofrequency wire after failure of conventional endovascular techniques. The complex and chronic central venous occlusion was successfully treated without complications. The combination of these techniques provided an endovascular solution and could be considered in select cases. (J Vasc Surg Cases and Innovative Techniques 2019;5:356-9.)

Keywords: Central venous occlusion; Radiofrequency wire; Image fusion

CASE REPORT

A 41-year-old African American woman with history of sickle cell disease and multiple central venous access devices in addition to myocardium infarct, cerebrovascular accident, and avascular necrosis of the right hip was referred with painful varicosities of the torso. Her physical examination revealed a right-sided chest port and bulging, tortuous veins in her lower neck, chest, and abdominal wall (Fig 1, *A*). Chest computed tomography angiography demonstrated a central venous occlusion (CVO) with extensive collateral veins. During the informed consent, the radiofrequency (RF) wire technique was presented as an alternative in the event of conventional technique failure. The patient consented to have her clinical case and images sent to publication.

Under general anesthesia, venous accesses were obtained in both arms through the basilic veins and into the right femoral vein; 6F- × 10-cm sheaths (Pinnacle; Terumo Medical, Somerset, NJ) were placed in the right basilic and femoral veins, and a long 7F- × 45-cm sheath (Destination; Terumo Medical) was placed in the left basilic vein. Central venography demonstrated occlusions of the right subclavian and brachiocephalic veins with collateral drainage through intercostal veins to the superior vena cava (SVC; Fig 1, *B*). More selective venography better delineated the occluded segment (Fig 1, *C*). The goal was to recanalize the brachiocephalic vein without crossing the supra-aortic vessels, mainly the left subclavian artery. After a failed attempt with conventional technique, the decision was made to proceed with RF wire technique. The integrated registration software on the Advantage Workstation (GE Healthcare, Milwaukee, Wisc) was then used to visualize the vascular anatomy (previously identified on preoperative computed tomography angiography) during real-time fluoroscopy (Fig 2). This software allows accurate fusion of images previously obtained by other modalities with the intraprocedure images based on anatomic landmarks such as bones. Those superimposed structures remain well aligned even with changes in obliquities.

Through the right femoral vein access, a 10-mm snare (ONE Snare; Merit Medical, Jordan, Utah) was advanced into a 5F Berenstein catheter (Boston Scientific, Marlborough, Mass) and positioned within the SVC stump (Fig 3, *A*). Through the left basilic vein access, a 20-degree angled tip 0.035-inch 260-cm nitinol PowerWire (Baylis Medical, Saint-Laurent, Quebec, Canada) was advanced through a 5F Berenstein catheter and positioned within the left brachiocephalic vein (Fig 2, *B*). The RF wire was advanced toward the snare in short increments of approximately 5 to 10 mm and its tip position checked intermittently using the integrated registration software and fluoroscopic projections in anteroposterior and right and left oblique views (Fig 3).

Before predilation of the track with balloon angioplasty, aortic arch digital subtraction angiography was performed through the left common femoral artery, and a flushing catheter was positioned in the ascending aorta (Fig 4, *A*). This was followed by acquisition of a cone beam computed tomography image. Both sets of image data were fused through the integrated registration software on the Advantage Workstation. This confirmed appropriate position of the RF wire in the retrosternal space without traversing the aortic arch or its branches (Fig 4, *B* and *C*). The RF wire was then exchanged for a 0.035-inch 260-cm stiff Advantage wire (Terumo Interventional Systems, Elkton, Md). The track was predilated using a 4- × 100-mm angioplasty balloon (Mustang; Boston

From the Division of Vascular and Interventional Radiology, Department of Radiology, Medical University of South Carolina.

Author conflict of interest: M.G. is a consultant for Baylis Medical and General Electric.

Correspondence: Ricardo Yamada, MD, Vascular and Interventional Radiology, Medical University of South Carolina, 25 Courtenay Dr, MSC 226, Charleston, SC 29425 (e-mail: yamada@musc.edu).

The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2468-4287

https://doi.org/10.1016/j.jvscit.2019.06.011

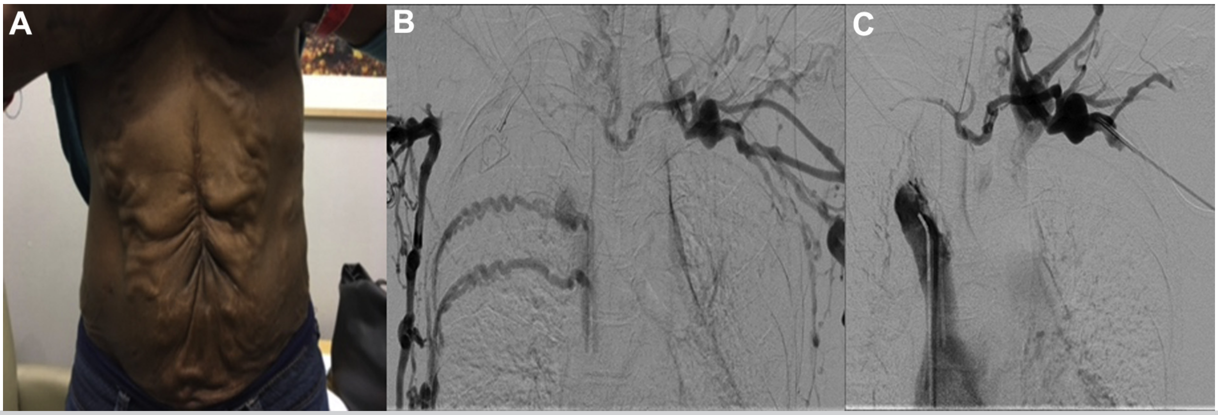

Fig 1. A, Preoperative abdominal image of 41-year-old African American woman with painful varicosities of the torso. Note multiple tortuous and enlarged varicose veins on the anterior chest and abdominal wall. **B,** Central venography performed through upper extremity accesses confirms central venous occlusion (CVO) involving right subclavian and bilateral brachiocephalic veins, with collaterals draining into the superior vena cava (SVC). **C,** Selective central venography through diagnostic catheters placed in the left upper extremity and femoral accesses better delineates the occluded left brachiocephalic segment.

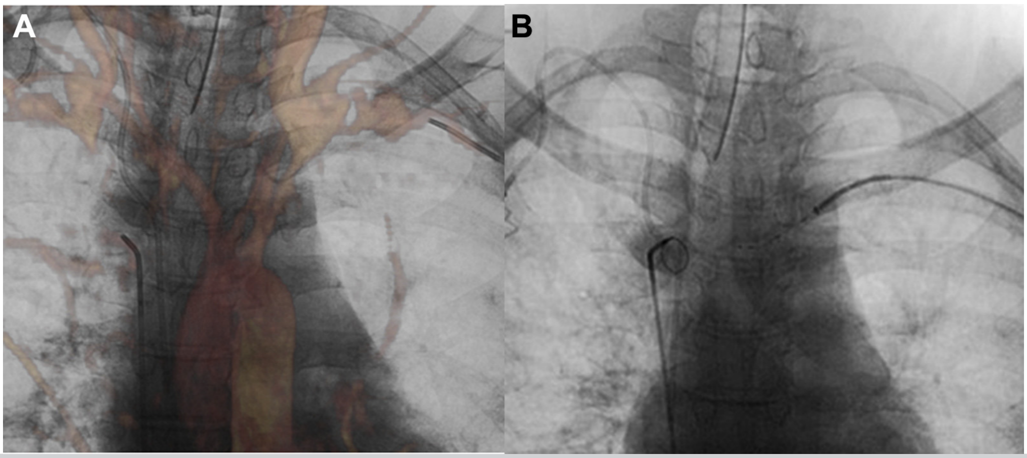

Fig 2. A, Vascular anatomy (*orange*) extracted from prior chest computed tomography angiography and fused with real-time fluoroscopy through the integrated registration software. This software allows accurate superimposition of images using anatomic landmarks such as bones. **B,** Image demonstrating the 10-mm snare positioned within the superior vena cava (SVC) stump through the right femoral vein and the radiofrequency (RF) wire positioned within the left brachiocephalic vein.

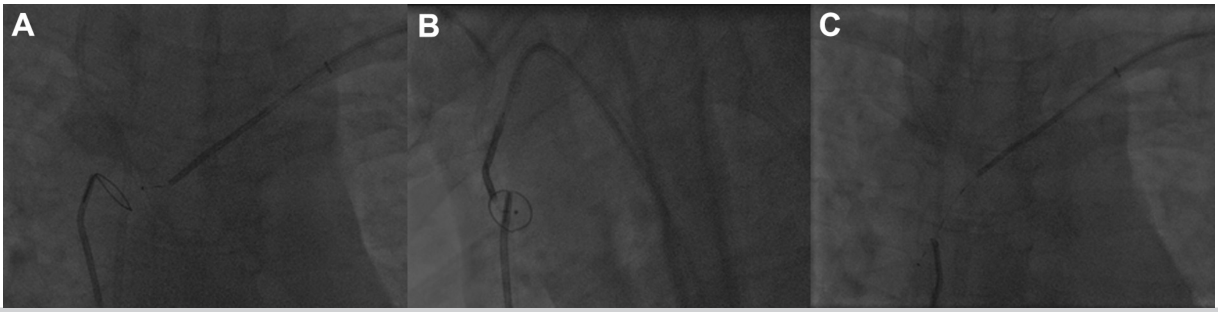

Fig 3. A, Anteroposterior view during advancement of the radiofrequency (RF) wire toward the snare, showing appropriate alignment**. B,** Oblique view confirming RF wire and snare in the same plane. **C,** Anteroposterior view showing the RF wire across the occluded segment and "captured" by the snare.

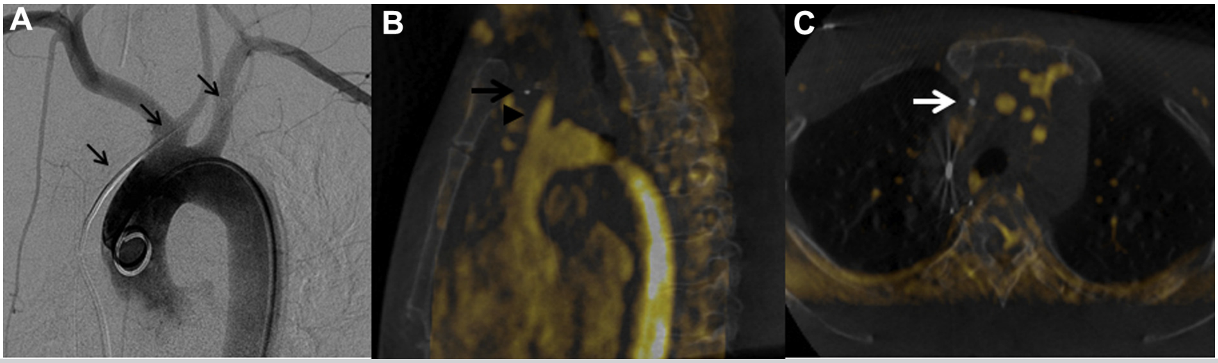

Fig 4. A, Catheter-based digital subtraction aortogram with flushing catheter positioned in the ascending aorta. Note the radiofrequency (RF) wire overlapping the supra-aortic vessels on this anteroposterior view (*arrows*). **B,** Aortogram fused with intraprocedural cone beam computed tomography image with sagittal reconstruction demonstrating the RF wire (*arrow*) within the retrosternal space anterior to the left subclavian artery (*arrowhead*). **C,** Aortogram fused with intraprocedural cone beam computed tomography image on axial reconstruction demonstrating appropriate location of the RF wire (*arrow*) within the mediastinum.

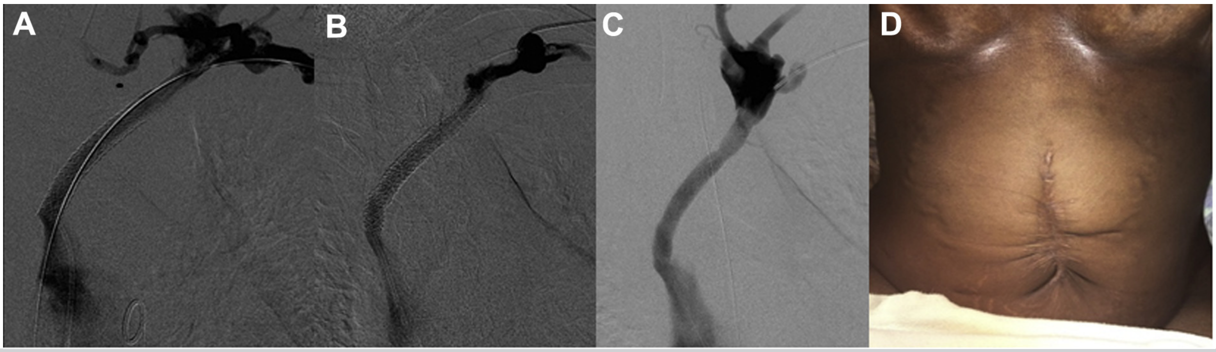

Fig 5. A, Completion venogram. **B,** The 3-week follow-up venogram. **C,** The 14-month follow-up venogram. **D,** Follow-up clinical evaluation shows flattening of the varicosities at 6 months after the procedure (this was obtained with different equipment and in a different room compared with the preprocedure clinical picture to account for any difference in brightness).

Scientific). Two 9- × 59-mm iCast (Maquet, Rastatt, Germany) stents were used to create a retrosternal bypass. Immediate, 3-week, and 14-month follow-up venograms showed patent bypass stents (Fig 5, *A-C*). Clinical evaluation during the 6-month follow-up visit demonstrated resolution of the chest and abdominal wall varicosities (Fig 5, *D*).

DISCUSSION

Conventional endovascular techniques have proved to be successful in most CVO recanalizations.[1,2] However, when the occlusion cannot be successfully crossed, the RF wire technique has been shown to be a safe and effective option.[3-6] Central venography in multiple projections is essential at the beginning of the case to properly identify the correct CVO stumps, their diameters, and length of the occlusion and to plan the RF wire trajectory.[3] Patients with CVO can develop a robust collateral venous network, including the azygos, hemiazygos, accessory hemiazygos, cervical, and internal and external thoracic and thoracolumbar veins. In some cases, the identification of the correct venous stumps can be complex.

The technical success of this procedure was defined by effectively creating an endovascular bypass overcoming the CVO. The image fusion provided accurate localization of the adjacent anatomy, such as the aortic arch and supra-aortic vessels. There was an 11-mm fat plane between the sternum and the supra-aortic vessels. With a better understanding of the anatomy, the procedure time and the risk of complications may be reduced. The angled RF wire tip allowed precise navigation through an arched trajectory from the confluence of the left internal jugular and subclavian veins to the proximal SVC. When patients have bilateral brachiocephalic venous occlusions, our experience has demonstrated that unilateral recanalization or bypass is enough to alleviate symptoms. We favor decompression of the right brachiocephalic system to avoid the supra-aortic vessels, but in this case, the right subclavian vein occlusion would add to the complexity of the procedure.

CONCLUSIONS

The successful outcome suggests that image fusion can be used in conjunction with RF wire technique to effectively treat CVOs with challenging anatomy in symptomatic patients after conventional endovascular techniques have failed.

REFERENCES

1. Horikawa M, Quencer KB. Central venous interventions. Tech Vasc Interv Radiol 2017;20:48-57.
2. Ozyer U, Harman A, Yildirim E, Aytekin C, Karakayali F, Boyvat F. Long-term result of angioplasty and stent placement for treatment of central venous obstruction in 126 hemodialysis patients: a 10-year single center experience. AJR Am J Roentgenol 2009;193:1672-9.
3. Guimaraes M, Schonholz C, Hannegan C, Anderson MB, Shi J, Selby B. Radiofrequency wire for the recanalization of central vein occlusions that have failed conventional endovascular techniques. J Vasc Interv Radiol 2012;23:1016-21.
4. Kundu S, Modabber M, You JM, Tam P. Recanalization of chronic refractory central venous occlusions utilizing a radiofrequency guidewire perforation technique. J Vasc Access 2012;13:464-7.
5. Sivananthan G, MacArthur DH, Daly KP, Allen DW, Hakham S, Halin NJ. Safety and efficacy of radiofrequency wire recanalization of chronic central venous occlusions. J Vasc Access 2015;16:309-14.
6. Gilbert P, Sanders K, Bourgeois A, Semaan A, Guimaraes M. Percutaneous iliocaval construction to treat symptomatic chronic lower extremity venous insufficiency. J Vasc Interv Radiol 2016;27:1168-9.

Submitted Apr 9, 2018; accepted Jun 26, 2019.