Radiofrequency Wire for the Recanalization of Central Vein Occlusions that Have Failed Conventional Endovascular Techniques

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ABSTRACT

Purpose: To report the technique and acute technical results associated with the PowerWire Radiofrequency (RF) Guidewire used to recanalize central vein occlusions (CVOs) after the failure of conventional endovascular techniques.

Materials and Methods: A retrospective study was conducted from January 2008 to December 2011, which identified all patients with CVOs who underwent treatment with a novel RF guide wire. Forty-two symptomatic patients (with swollen arm or superior vena cava [SVC] syndrome) underwent RF wire recanalization of 43 CVOs, which were then implanted with stents. The distribution of CVOs in central veins was as follows: six subclavian, 29 brachiocephalic, and eight SVC. All patients had a history of central venous catheter placement. Patients were monitored with regular clinical evaluations and central venography after treatment.

Results: All 42 patients had successful recanalization of CVOs facilitated by the RF wire technique. There was one complication, which was not directly related to the RF wire: one case of cardiac tamponade attributed to balloon angioplasty after stent placement. Forty of 42 patients (95.2%) had patent stents and were asymptomatic at 6 and 9 months after treatment.

Conclusions: The present results suggest that the RF wire technique is a safe and efficient alternative in the recanalization of symptomatic and chronic CVOs when conventional endovascular techniques have failed.

ABBREVIATIONS

CVO = central vein occlusion, LAO = left anterior oblique, RAO = right anterior oblique, RF = radiofrequency, SVC = superior vena cava

Incidences of central vein occlusions (CVOs) related to central venous catheters have been reported to be approximately 3%–38% (1,2). Some CVOs will cause symptoms such as swollen arms and superior vena cava (SVC) syndrome, which may justify treatment. Regardless of whether it is benign or malignant, a CVO may be treated by conventional endovascular techniques.

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The endovascular treatment of CVOs with use of percutaneous transluminal angioplasty and stents has been shown to be safe and effective, but these techniques are only possible when the lesion can be successfully crossed (3,4). The literature suggests that as many as 24% of CVOs cannot be recanalized with standard techniques (5). These patients have few alternatives to living with their symptoms, undergoing access ligation, or having a surgical bypass procedure. There has been some interest in the use of sharp recanalization techniques for lesions resistant to standard crossing techniques, but concern has been raised about the high degree of risk associated with these procedures (6–8). In these cases, the radiofrequency (RF) wire technique may provide an opportunity for CVO recanalization with a minimally invasive technique. Studies have shown the ability of the technology to recanalize occlusions in the peripheral vessels (9) and in the bile duct (10). More recently, small case series have confirmed the effectiveness of the RF wire in the recanalization of malignant and benign CVOs (11,12).

The goal of this investigation was to evaluate the feasibility and safety of using the RF wire in the recanalization of symptomatic, chronic CVOs after conventional endovascular techniques have failed.

MATERIALS AND METHODS

This retrospective study received institutional review board approval before clinical information was obtained from digital patient records. Between January 2008 and December 2011, 42 consecutive patients underwent the RF wire technique to treat 43 benign and chronic (ie, symptoms lasting > 30 d) CVOs. Venous occlusions were located in the subclavian vein (n = 6), brachiocephalic vein (n = 29), and SVC (n = 8), and ranged in length from 1.5 to 10 cm. Patient characteristics are shown in the **Table**. The RF wire technique was used only in symptomatic patients in whom attempts to recanalize the CVO via conventional techniques and standard devices had failed. Failed attempts were defined as unsuccessful recanalization after using various combinations of hydrophilic guide wires and semicurved catheters (according to the operator's preference) for 15 minutes. Patients referred from other centers after failed recanalization attempts also underwent 15 minutes of attempted crossing at the present study site before being considered eligible for the RF wire technique. Access method was dependent on patient anatomy. Dual venous access was obtained through the common femoral vein and the brachial vein ipsilateral to the occluded side in all patients; however, in nine cases, bilateral brachial veins or internal jugular veins were also accessed to better define the anatomy of the central veins. Eleven patients had more than one venous segment occluded, and the predominant vein affected was selected during the distribution analysis.

Whenever possible, the patient had a preprocedural clinical visit with the interventionist. It included the evaluation of symptoms, accesses sites, presence of cardiac failure/pulmonary hypertension (that could decompensate after central venous recanalization, leading to an increase in preload to the right heart), and possible coagulopathy. Chest computed tomographic (CT) angiography was used in planning the procedure (**Fig 1a**). Multiplanar reformatted images were used to define the anatomy of the venous stump (diameter of the venous segment to be recanalized, length and characteristics of the interposed segment to be crossed) and the adjacent tissues/organs to rule out variations of the superior mediastinum anatomy.

After the procedure, patients were monitored with regular clinical evaluations and central venography. Immediate revaluation was performed if the patient developed symptoms at any time. Technical success was defined as successful puncture and crossing of the obstruction, followed by balloon angioplasty and stent placement. Clinical success was defined at follow-up as the absence of symptoms and presence of a functional arteriovenous shunt inpatients who had surgical dialysis access.

Table. Summary of Patient Characteristics

Characteristic	Value
Sex	
Male	15
Female	27
Age (y)	
Mean	53
Range	25–78
History of long-term (>30 d) central catheter placement	42
End-stage renal disease	41
Malfunctioning AV shunt ipsilateral to symptomatic side	17
Crohn disease	1
Unilateral diffuse arm edema	34
Associated venous stasis ulceration	7
Face swelling	8

AV = arteriovenous.

Device Specifications

The PowerWire RF Guidewire (Baylis Medical, Montreal, QC, Canada) is a low-friction guide wire capable of delivering RF energy in its tip when connected to an RF Puncture Generator (Baylis Medical). Mechanical advancement of the wire is thus augmented by application of RF energy when the electrode tip is in direct contact with the target tissue.

The shaft of the wire is polytetrafluoroethylene-insulated and has a stiff proximal end that transitions to a more flexible distal end (9,10). Its tip is short, rounded, atraumatic, and radiopaque. There are three different tip shapes available: straight, 45° angled (arch length, 0.5 cm), and relaxed 45° angled (arch length, 1.5 cm). We used the 0.035-inch, 250-cm-long wire with a 5-cm distal floppy tip. The device allows for the use of balloon catheters over its 250-cm exchange length.

The generator, which has a fixed voltage of 100–120 V and RF of 455–465 kHz (12), had the power set to 25 W and activation time to 2 seconds. The device requires a grounding pad be applied to the patient's thigh to complete the circuit, as it is a monopolar system.

Procedure

Informed consent was obtained before the procedures. Patients were given moderate sedation with intravenous administration of midazolam and fentanyl; however, four patients had an indication for anesthesiology-assisted procedures as a result of respiratory comorbidity (n = 1), cardiac comorbidity (n = 1), and difficult airway access (Mallampati classification IV; n = 2).

Under fluoroscopic guidance, simultaneous upper extremity (brachial approach) and central (femoral approach) venograms were used to define the CVO segment (length, diameter of venous stumps) and to determine the approach