

# Modified Pull-Through Technique for Cardiac Resynchronization Therapy Upgrades

in Patients with Occluded Access Veins

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*The number of procedures for upgrading implantable devices for cardiac resynchronization therapy has increased considerably during the last decade. A major challenge that operators face in these circumstances is occlusion of the access vein. We have modified a pull-through method to overcome this obstacle.*

*Six consecutive patients with occluded access veins and well-developed collateral networks underwent a procedure in which the occluded vein was recanalized by snaring the existing atrial lead via transfemoral access. Upgrading the device was successful in all patients; none had intraprocedural complications. Our experience shows that our modified pull-through technique may be a feasible alternative for upgrading cardiac resynchronization therapy in patients with venous occlusion. (Tex Heart Inst J 2020;47(1):23-6)*

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**T**he number of procedures in patients who have existing implantable electronic devices has increased substantially in recent years. In many cases, patients need a newer cardiac resynchronization therapy (CRT) device. At our institution, one third of all patients undergoing CRT device implantation received an upgrade.

One of the biggest challenges in these procedures is occluded access veins. A known limitation in some current techniques is that contralateral tunneling is bilateral and too invasive. We present an alternative, a modified pull-through technique, which involves transfemoral snaring of an existing lead.

## Patients and Methods

From January 2013 through September 2015 at our institution, 300 CRT pacemaker and implantable cardioverter-defibrillator (ICD) implantations were performed, of which 95 (31.6%) were CRT upgrades. In 6 patients (Table I), routine upper-extremity venograms revealed occluded access veins and well-developed collateral networks. All patients had iatrogenic left bundle branch block caused by 100% right ventricular pacing. Four patients had a dual-chamber ICD and 2 had a dual-chamber pacemaker. Three patients had a left-sided implant. After giving their informed consent, all 6 patients underwent recanalization of the occluded access vein with use of the pull-through technique.

We initially used the pull-through technique in 2 patients who had a malfunctioning right atrial (RA) lead. Their positive outcomes prompted us to sacrifice a normally functioning RA lead to treat 4 subsequent patients who had occluded access veins.

## Pull-Through Technique

All procedures were done with the patients under general anesthesia and with 2 operators, one manipulating the lead, and the other, the snare. Laser and mechanical extraction tools were always available in case conventional lead extraction was needed.

After the generator was explanted, the RA lead was released from the tissue in the pocket by cutting away the suture sleeves and completely unraveling the lead. A standard RA stylet was inserted into the lead to ensure that the lead lumen was passable. A gentle push-and-pull maneuver was used to free the lead, and the helix was retracted, when possible. At the same time, the femoral vein was entered through the groin with use of the Seldinger technique. Next, a Needle's Eye Snare® (Cook Medical Inc.) was

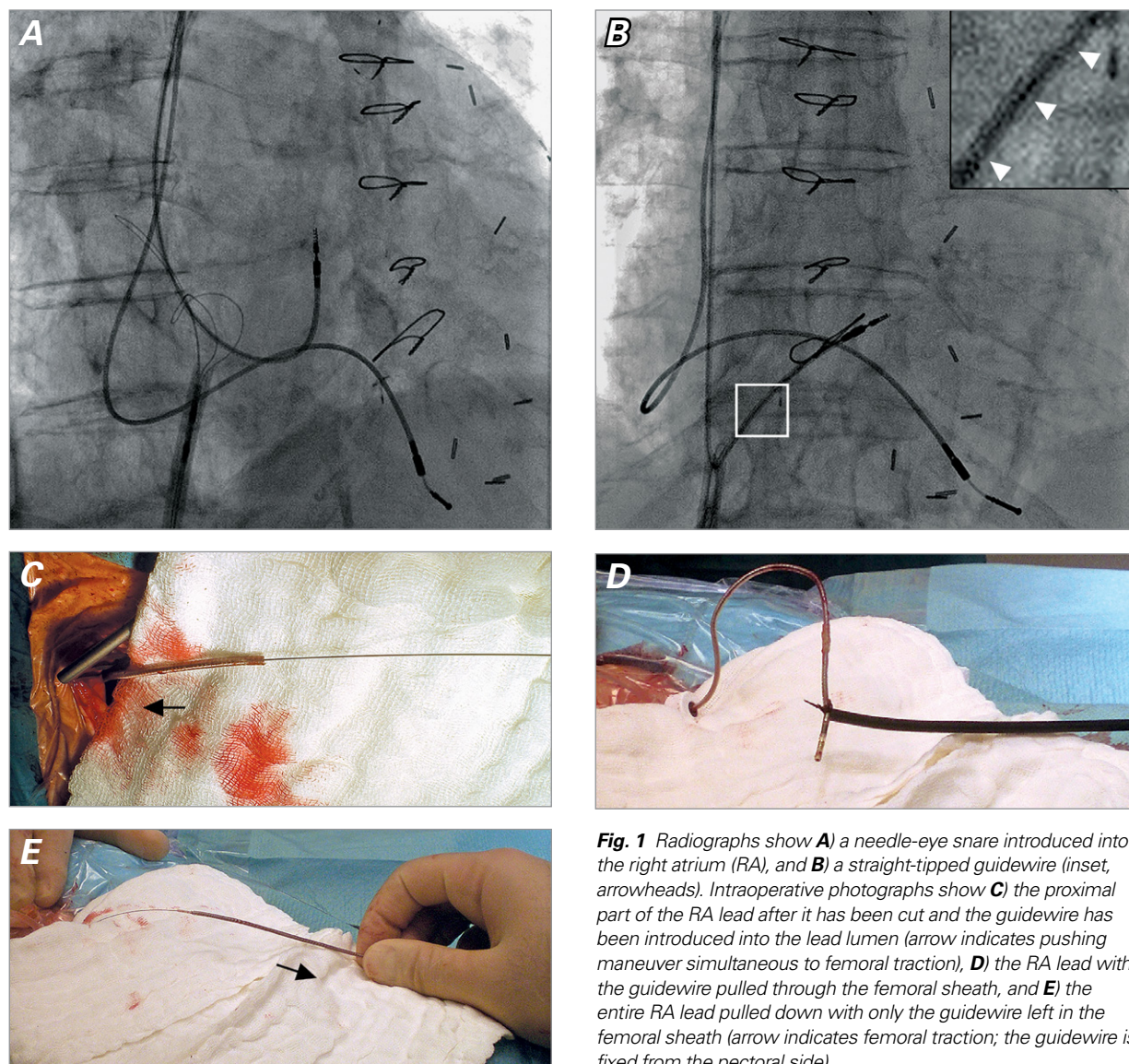
**TABLE I.** Baseline Characteristics of the Patients

Variable	Value
Age (yr)	69.8 ± 8.4
Female	3 (50)
Body mass index (kg/m <sup>2</sup> )	24.3 ± 5.3
Heart failure	6 (100)
LVEF	0.29 ± 0.14
Coronary artery disease	6 (100)
Hypertension	5 (83.3)
Diabetes mellitus	1 (16.7)
Atrial fibrillation	6 (100)
Chronic kidney disease	6 (100)
Peripheral vascular disease	6 (100)
Years after first implantation	5.8 ± 3.4

LVEF = left ventricular ejection fraction

Data are presented as mean ± SD or as number and percentage.

delivered near the RA lead through a long, flexible 12F sheath (Cook Medical) that was placed coaxially within an outer 16F femoral sheath (Cook Medical) with a hemostasis valve at its proximal end (Fig. 1A). Then, the stylet was removed from the RA lead, and the lead connector was carefully cut, keeping the inner coil lumen of the lead open. A moderate-support, straight-tipped, 0.014-in × 185-cm PT<sup>2</sup>® hydrophilic guidewire (Boston Scientific Corporation) was inserted into the inner coil lumen and advanced as far as possible into the lead (Fig. 1B). After this, the second operator carefully maneuvered the lead from the pectoral side, gently pushing the lead and the guidewire from the pacemaker pocket side toward the femoral sheath. The first operator managed the snare from the femoral access in order to snare the lead with the guidewire inside it (Fig. 1B–C). After successful entrapment, the lead (and guidewire) were



**Fig. 1** Radiographs show **A**) a needle-eye snare introduced into the right atrium (RA), and **B**) a straight-tipped guidewire (inset, arrowheads). Intraoperative photographs show **C**) the proximal part of the RA lead after it has been cut and the guidewire has been introduced into the lead lumen (arrow indicates pushing maneuver simultaneous to femoral traction), **D**) the RA lead with the guidewire pulled through the femoral sheath, and **E**) the entire RA lead pulled down with only the guidewire left in the femoral sheath (arrow indicates femoral traction; the guidewire is fixed from the pectoral side).

dragged down into the long sheath with use of careful traction, and the entire assembly was pulled out from the femoral sheath (Fig. 1D–E). After being pulled out from the femoral sheath, the entrapped lead and guidewire were released from the snare, the lead was pulled away, and the guidewire was kept in the venous system to maintain access through the occlusion.

Once access was obtained, balloon angioplasty of the vein was performed by using 3- to 4-mm  $\times$  20-mm NC Sprinter® noncompliant coronary angioplasty balloons (Medtronic) (Fig. 2). After the access vein was recanalized, new left ventricular (LV) and RA leads were implanted in standard fashion. The femoral-vein puncture site was closed with use of a pursestring suture.

days. At 3-, 6-, and 12-month follow-up, the devices were functioning properly, and the lead parameters were normal. No major bleeding or infections occurred. One patient had a pocket hematoma, resulting in a relatively long hospital stay.

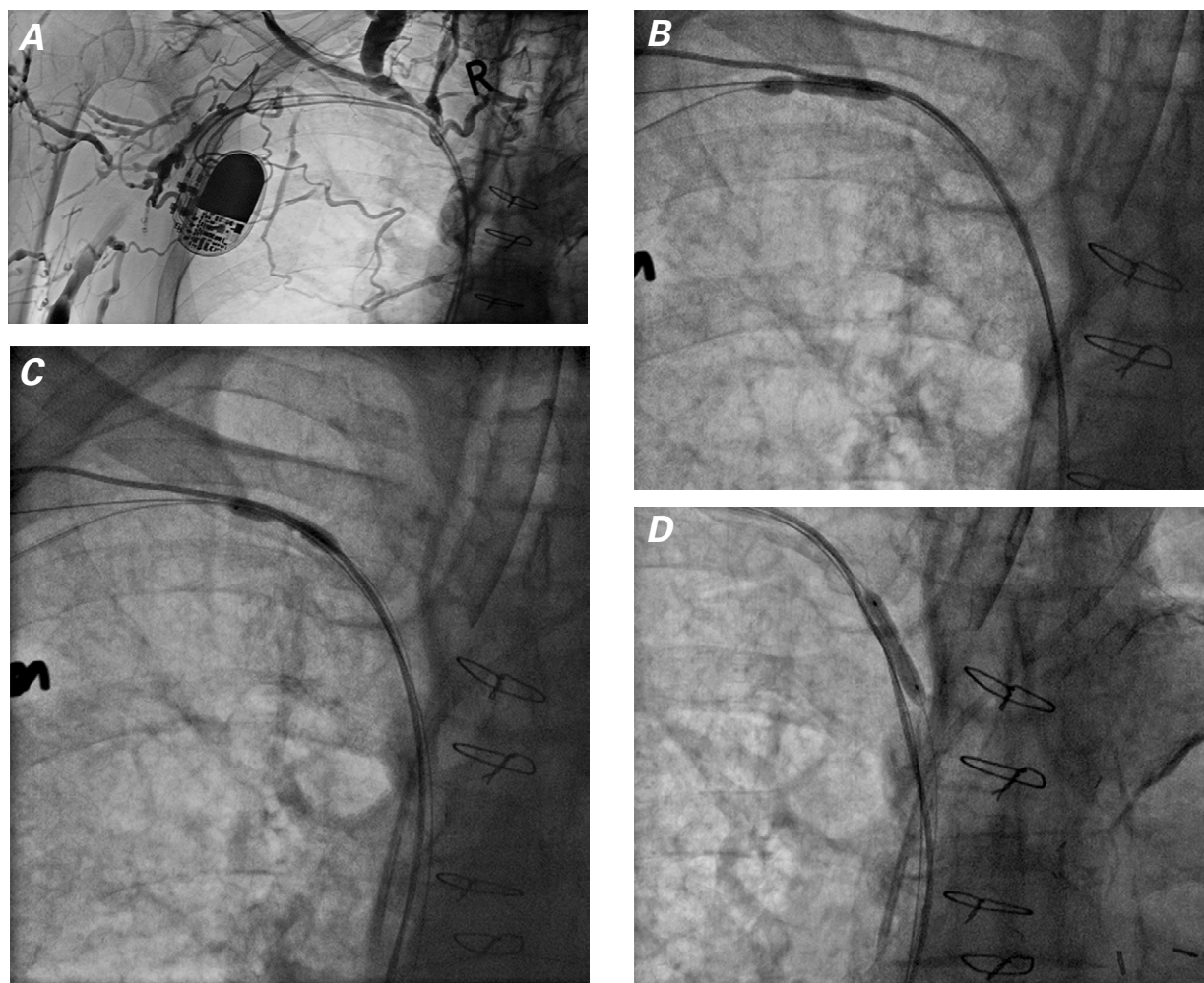
All patients underwent balloon angioplasty, with a mean of  $6.1 \pm 3.8$  balloon inflations per patient (mean inflation pressure,  $14.6 \pm 8.9$  atm) to recanalize the occluded access vein. Mean procedural and fluoroscopy times were  $188.33 \pm 35.1$  and  $36 \pm 12.05$  min, respectively. In 5 patients, the RA and LV leads were implanted after venous recanalization. In one patient, who had permanent atrial fibrillation, only the LV lead was implanted.

## Results

All 6 patients underwent successful CRT upgrade without intraprocedural complications and were discharged from the hospital after a mean of  $3.6 \pm 2.2$

## Discussion

Up to 12% of all patients with CRT devices have occluded access veins 6 years after implantation.<sup>1</sup> In our experience, 6.3% of patients undergoing CRT upgrade



**Fig. 2** Radiographs show **A)** central venous occlusion with a collateral network, and **B), C), D)** balloon angioplasty with use of noncompliant coronary angioplasty balloons.

procedures had venous occlusion and well-developed collateral networks. Various techniques have been proposed to overcome access-vein occlusion. One method, contralateral lead tunneling into the device pocket,<sup>2</sup> is bilateral and overly invasive. Another example, endovascular recanalization of the occluded central venous system, has proved highly effective for pacemaker upgrade procedures and has a low rate of vascular complications.<sup>3</sup> Moreover, another technique, laser extraction, is expensive and not available everywhere.

Schilling<sup>4</sup> reported the largest cohort of patients with venous occlusion who underwent ipsilateral lead replacement without the use of lead-extraction techniques. His group also used snaring. Their drag-through technique is similar to our technique, with a few minor differences. The guidewire for the drag-through technique is inserted between the inner coil and external insulation, whereas we used the inner coil lumen of the RA lead after having verified that the lumen was passable (by inserting the stylet). In the drag-through technique, a guidewire is introduced into the RA, and a new sheath is introduced over it. In contrast, in our technique, the RA lead and guidewire are pulled through the whole body, and an operator stabilizes the distal part of the wire from the femoral position.

The only pull-through technique similar to ours was described by Rogers and colleagues.<sup>5</sup> They introduced a guidewire into the inner coil lumen of the LV lead and then pulled it through from the femoral sheath. They had to perform balloon angioplasty to be able to insert the sheath for lead implantation. Our technique for pull-through is like theirs, but we used the RA lead. We also had to use balloon angioplasty in all cases. Another method to overcome the problem of an occluded venous system is to extract (and sacrifice) one of the leads with mechanical or laser extraction tools to gain access to the vein.<sup>6,7</sup>

In our series, the pull-through technique was effective for complex CRT upgrade procedures, especially in patients with a malfunctioning RA or ventricular lead. Contralateral lead tunneling is far from ideal in these cases and results in lead redundancy. For example, if an upgrade is needed from a dual-chamber pacemaker to an ICD (the most common situation), new LV and

ICD leads are needed. If contralateral tunneling is done, these 2 leads are added, and the right ventricular pacing lead is abandoned, which leaves 4 leads traversing the superior vena cava. In contrast, the pull-through technique enables ipsilateral access by sacrificing the right ventricular lead, avoiding lead redundancy, and leaving the contralateral side intact for a possible future implant if the current system were to become infected and need to be extracted. This method is also applicable in situations of bilateral venous occlusion when it is not possible to use the contralateral side for the implant. A major limitation of the technique is the firm attachment of the lead to the scar binding site(s), which would render the lead essentially immobile and not feasible for snaring.

In conclusion, we consider our modified pull-through technique to be a feasible alternative for CRT upgrade procedures in patients with occluded access veins.

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