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Percutaneous Treatment for Pacemaker-Associated Superior Vena Cava Syndrome

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CHAN, A.W., ET AL.:Percutaneous Treatment for Pacemaker-Associated Superior Vena Cava Syndrome. *Superior vena cava (SVC) obstruction is an uncommon but serious complication associated with permanent pacemaker implantation. The mechanical stress associated with pacemaker wires may lead to vessel wall inflammation, fibrosis, and thrombus formation, and ultimately to venous stenosis and occlusion. The surgical treatment of pacemaker related SVC syndrome requires thoracotomy and carries significant morbidity. This article illustrates the authors' initial experience with a "one-step" percutaneous approach for this problem, consisting of percutaneous retrieval of a pacemaker system, followed by venous revascularization with angioplasty and stenting, and installation of a new pacemaker device. (PACE 2002; 25:1628–1633)*

pacemaker, stents, superior vena cava syndrome

Introduction

About 170,000 patients each year undergo pacemaker implantation in the United States,[1] and pacemaker renewal is increasingly common with the aging population.[2] Fibrosis around the pacemaker leads in the cardiac chambers, superior vena cava (SVC), or subclavian and innominate veins, can make lead removal and replacement difficult. Telescoping sheaths made of polymer and/or steel material can be applied with countering force for fibrous overgrowth that resists traction.[3–5] However, when these are complicated with SVC syndrome, surgical removal and reimplantation of pacing leads, together with venous reconstruction has been the standard treatment.[6,7] This article reports the authors' initial experience with a percutaneous approach that consists of extraction of the pacemaker system with an excimer laser sheath, followed by percutaneous venous revascularization and stent placement, and implantation of a new pacemaker generator and leads with the same venous access.

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Percutaneous Techniques

Excimer Laser Sheath Pacemaker Lead Extraction

The technique and the procedural outcome for the pacemaker lead extraction with the laser sheath have been previously described.[8] Briefly, the 35-cm long sheath consists of thin inner (8.4 Fr) and outer (12 Fr) polymer walls between which a single layer of optical fibers has been spirally wrapped and ends as a single circumferential ring at the distal tip. The proximal end of the sheath is attached to the CVX-300 Excimer XeCl Laser System (Spectranetics Corp., Colorado Springs, CO, USA). This system has an energy delivery of 30–60 mJ/mm^2 in 135-ns pulses and a frequency of 25–40 Hz. The combined effect of photochemolysis and photothermal ablation causes the tissue in contact with the distal tip to disintegrate into particles < 5 μm in diameter. Since the penetration depth of the system is approximately 100 μm, the laser energy is completely absorbed by the tissue, allowing local and precise removal of the fibrotic tissue directly surrounding the leads.

After the locking stylet is placed in the lead, a Teflon outer sheath is preloaded over the laser sheath before the stylet and leads are threaded through the assembly. When the assembly reaches the first adhesion, a 5-second burst of excimer laser energy is delivered during gentle forward pressure on the laser sheath and withdrawal trac-

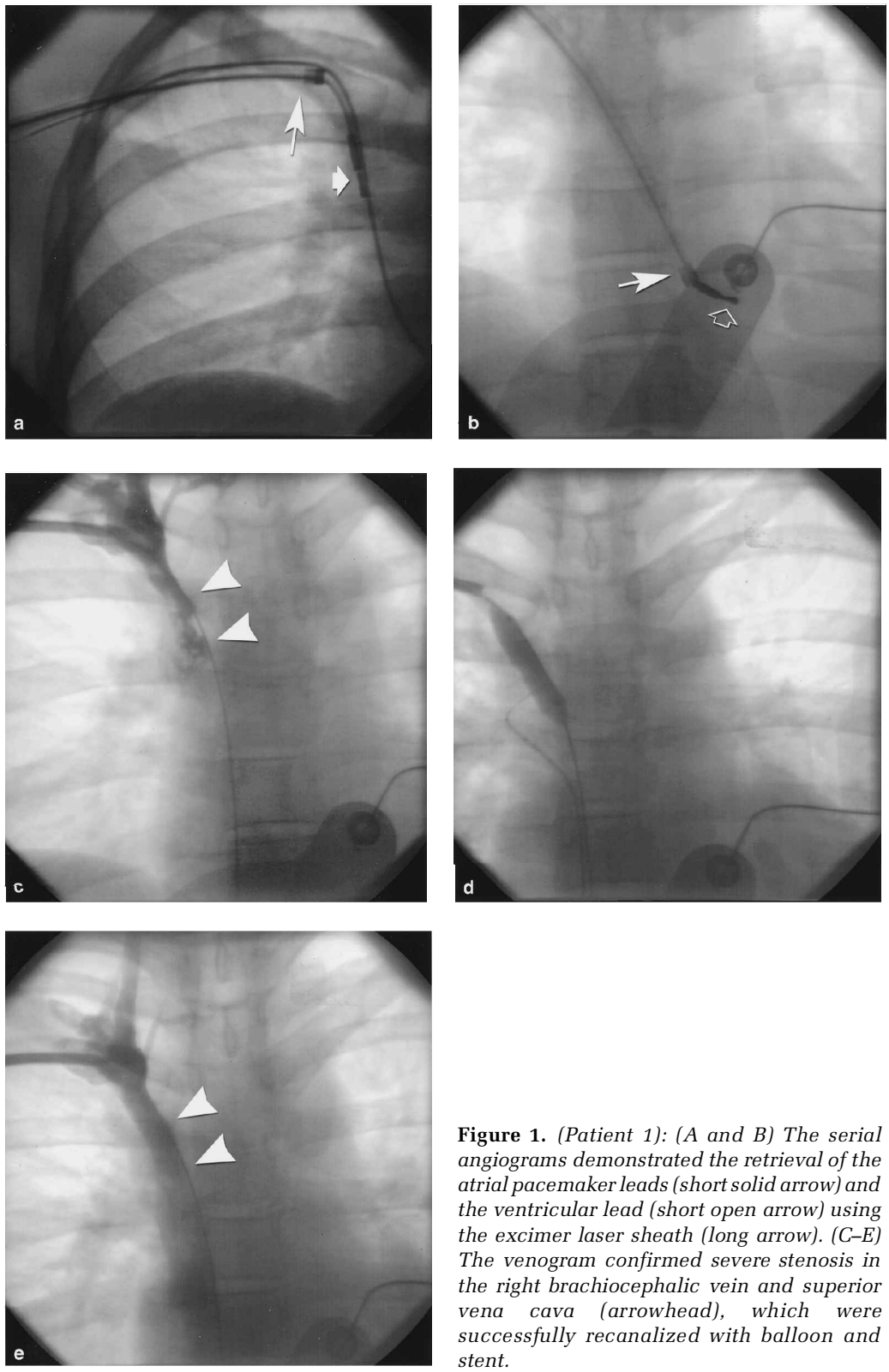


Figure 1. *(Patient 1): (A and B) The serial angiograms demonstrated the retrieval of the atrial pacemaker leads (short solid arrow) and the ventricular lead (short open arrow) using the excimer laser sheath (long arrow). (C–E) The venogram confirmed severe stenosis in the right brachiocephalic vein and superior vena cava (arrowhead), which were successfully recanalized with balloon and stent.*

Table I.

Procedural Data

Patient	Years from the First Pacemaker Implant	Lesion Site	Pre/Post-percent Stenosis	Guidewire	Balloon Catheter(s)	Stent Type	Final Results
1	11	R-BcV, SVC	95/0	Magic Torque	8 × 30 and 10 × 20 mm Opta LP	10 × 20 mm SMART	Successful
2	16	SVC, L-BcV	90/0	Magic Torque	7 × 40 and 12 × 40 mm Opta LP	BcV: 14 × 60 SMART SVC: 14 × 40 SMART	Successful
3	6	R-SubV, SVC	90/0	Glidewire	8 × 40 Opta LP, 12 × 40 Medi-Tech	R-SubV: 12 × 40 mm SMART SVC: 14 × 20 SMART	Successful
4	17	SVC, R-BcV, R-SubV	100/0	Glidewire	SVC: 10 × 40 mm R-InV: 12 × 40 mm Opta LP	R-SubV: 10 × 40 mm SMART, 10 × 20 SMART	Ruptured valve chordae prohibiting transvenous lead placement

BcV = brachiocephalic vein; R = right; SubV = subclavian vein; SVC = superior vena cava; L = left.

tion on the locking stylet. Continuous advancement of the assembly is performed until the lead is free from adhesions or until the sheath tip is a few millimeters away from the endocardium. At the end, the outer sheath is advanced, and countertraction is applied to remove the lead.

Intravenous Stenting

Following lead extraction, a cinevenogram is recorded by injecting contrast antegradely through the previously placed 12 Fr sheath placed ipsilaterally in the subclavian vein, and an 18-gauge angiocath in the contralateral antecubital fossa. To further define the anatomy, additional venograms can be recorded by injecting contrast via a multipurpose catheter placed distal to the obstruction via an 11 Fr sheath in the right or left femoral vein. The lesion is crossed with an 0.035-inch guidewire (e.g., Magic Torque or Glidewire, Boston Scientific, Watertown, MA, USA). Following balloon catheter dilatation, self-expanding nitinol stent(s) are deployed. Postdilation with noncompliant balloon catheter is performed to optimize angiographic results. The new pacemaker leads are then implanted through the stented vein. Postprocedural antiplatelet therapy consists of clopidogrel for 1–3 months, in addition to life-long aspirin.

Case Reports

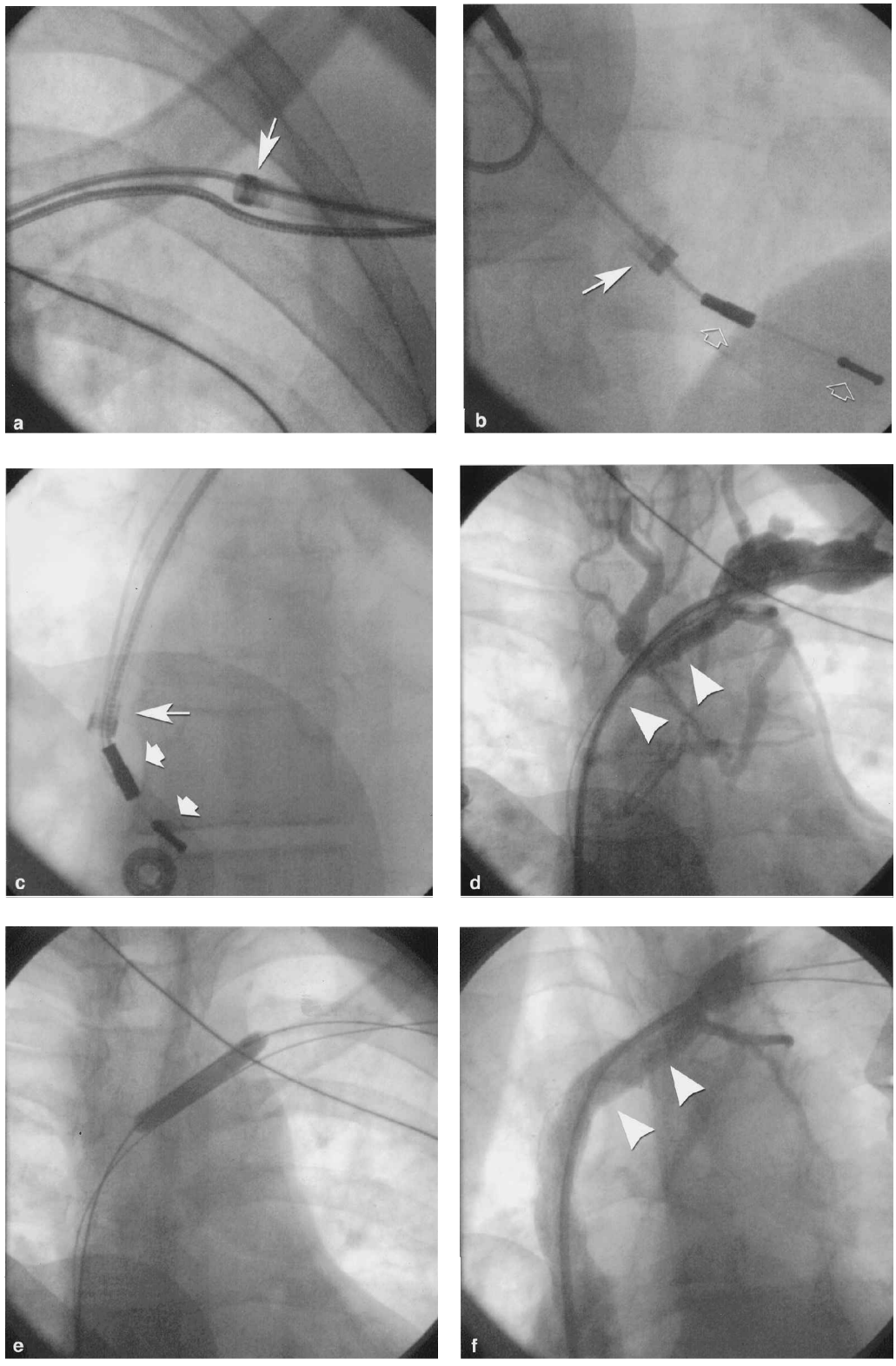
Patient 1

A 24-year-old woman was referred for replacement of the pacemaker system 11 years after implantation because of insulation failure of the pacemaker leads and SVC syndrome secondary to partial thrombosis within the right subclavian vein. The atrial and ventricular pacemaker leads were extracted without difficulty using excimer laser sheaths (Fig. 1, Table I). Sequential balloon inflations (8 × 30 and 10 × 20 mm Opta LP, Cordis, Miami, FL, USA) across the occlusive site resulted in significant recoil and a small dissection. A 10 × 20 mm self-expanding SMART (Cordis) stent was deployed in the right brachiocephalic vein, followed by implantation of new dual chamber pacemaker system over the right pectoral region. She was discharged on the following day with 3 months of clopidogrel and life-long aspirin.

Patient 2

At 16 years after pacemaker implantation, the 48-year-old patient presented with SVC syndrome. After laser-assisted extraction, venogram confirmed severe stenosis in the left innominate vein and a focal lesion in the SVC (Fig. 2). These

Figure 2. *(Patient 2): (A and C) Extraction of the old pacemaker leads within the left brachiocephalic vein using excimer laser sheath (long arrow). (Atrial lead, short solid arrow; ventricular lead, short open arrow) (D–F) The location of the occlusive site was confirmed within the left brachiocephalic vein (arrow head). Balloon predilation was carried out, followed by stenting within the left brachiocephalic vein and the superior vena cava.*


a
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lesions were crossed with a Magic Torque wire (Table I). Balloon predilation of the brachiocephalic vein and SVC was performed using 7 × 40 mm Opta LP catheter, and this was followed by stent placement in each of the brachiocephalic veins (14 × 60 mm SMART stent) and SVC (14 × 40 mm SMART stent). Postdilation was performed with the use of 12 × 40 mm Opta LP catheter. A new pacemaker system was implanted at the same site and the patient was discharged on the following day after an uneventful recovery.

Patient 3

A 45-year-old woman had a pacemaker implantation 6 years ago. Three months prior to index hospitalization, she developed right brachiocephalic vein thrombosis and underwent thrombolysis and balloon angioplasty. She presented with recurrence of symptoms.

After laser-assisted lead extraction, a venogram through an 8 Fr Mullins sheath (USCI, Billerica, MA, USA) inserted in the right antecubital vein confirmed a complete occlusion of the right brachiocephalic vein and severe stenosis in SVC. After crossing the lesions with a 0.035-inch Glidewire and balloon dilation using 8 × 40 mm Opta LP balloon catheter, a 12 × 40 mm SMART stent was deployed across the occluded portion of the right subclavian vein and was postdilated with a 12 × 40 mm Medi-Tech (Boston Scientific, Watertown, MA, USA) balloon catheter. With the pullback of the Mullins sheath from the right atrium to the right brachiocephalic vein, a 6-mmHg gradient was detected and hence a 14 × 20 mm SMART stent was deployed in the SVC. No residual stenosis was present and a new pacemaker system was implanted through the same vessels. The patient was discharged the next day on aspirin and clopidogrel.

Patient 4

A 49-year-old man presented with recurrent SVC syndrome, which manifested as facial and upper extremity edema, exertional dyspnea, and presyncope, at 17 years after his first permanent pacemaker implantation. He had history of bilateral brachiocephalic venous occlusion, and pacemaker pocket infection that required surgical debridement. After an apparently uneventful lead extraction with laser assistance, a venogram revealed a subtotal occlusion of the right subclavian vein. The lesion was crossed with a stiff angled Glidewire. Balloon inflation was performed within the innominate and the subclavian veins, and the SVC, using a 10 × 40 and a 12 × 40 mm Opta LP balloon. A 10 × 40 and a 10 × 20 mm SMART stents were deployed within the subclavian veins due to residual stenosis. The venous pressure dropped from 40 to 14 mmHg with the procedure. At this time, severe tricuspid regurgitation was noted secondary to a torn chordae of the anterior tricuspid valve leaflet, prohibiting transvenous placement of the permanent pacemaker lead in the right ventricle. The patient underwent surgical replacement of the tricuspid valve and epicardial electrode implantation.

Follow-Up

During a median of 9 (range 6–12) months of follow-up, no patients had return of symptoms of venous obstruction or pacemaker malfunction.

Discussion

This article describes a percutaneous approach for the treatment of SVC syndrome caused by fibrotic adhesions around permanent pacemaker leads. With an increasing number of patients receiving pacemakers and implantable cardioverter defibrillators, secondary venous obstruction is likely to become more common. Through the joint effort of electrophysiologists and interventional cardiologists, this originally complex problem can be resolved by a "one-step" percutaneous approach. This method is associated with considerable less discomfort to the patients, and can be considered as an alternative to surgery.

The efficacy of lead extraction using an excimer laser has been studied in the Pacing Lead Extraction with the Excimer Sheath (PLEXES) trial.[8,9] The success rate of lead extraction was 95%. Of 153 patients randomized to laser-assisted extraction, 4 (2.4%) patients had immediate major complications. These included laceration of the lateral atrial wall in two patients resulting in tamponade and one death, and laceration of SVC causing hemothorax. One patient had severe tricuspid insufficiency after failed lead extraction and was subsequently treated medically. Although these complications were at times life-threatening, the incidence remained low and was comparable to historical controls using the traditional approach.[10] Laser energy reduced the counterpressure required to extract the leads, and was not considered related to any of the major complications. In light of the potential periprocedural complications, surgical backup for percutaneous lead extraction is mandatory.

Direct comparison of the efficacy between angioplasty alone and stenting of venous lesions has not been reported. Several series have suggested

that stenting provides satisfactory early and intermediate results.[11–15] However, most of the previous series involved cases related to indwelling dialysis catheters or to extrinsic compression due to malignancy. Since many of these series involved patients with limited life expectancy, the exact long-term patency rate remains unknown. Initial procedural success rates varied from 85 to 100% and all successful cases resulted in symptomatic relief of central venous obstruction. In the series by Oderich et al.[15] 94% of the patients were event-free at 1 year.

Unlike the present cases, stainless steel self-expanding stents were used in previous series of central venous stenting.[12,13] Compared with stainless steel self-expanding stents, nitinol stents have greater radial strength, conform better in tortuous vessels, and may have lower restenosis rates. The use of adjunctive thrombolysis and thromboaspiration techniques has been used by some investigators.[11] Antithrombin or fibrinolytic agents are not routinely used to prevent bleeding complications secondary to occult venous laceration or perforation during pacemaker lead removal. Consensus for antiplatelet therapy after central venous stenting has not been established. Currently, the authors routinely administer clopidogrel for 3 months in addition to lifelong aspirin.

Summary

The preliminary data suggest that percutaneous laser-assisted lead extraction followed by intravenous stenting and reimplantation of permanent pacemaker is feasible, safe, and may provide an alternative to surgery for a complex problem. The true long-term benefit of this approach will require observation of a larger number of patients for several years after the procedure.

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