INNOVATIVE COLLECTIONS

COMPLEX CASE STUDY

Percutaneous Treatment of Symptomatic Superior Vena Cava Syndrome Following Permanent Pacemaker Implantation

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ABSTRACT. Central venous stenosis or occlusion commonly occurs following implantation of cardiac implantable electrophysiologic devices (CIED), either permanent pacemakers or implantable cardioverter-defibrillators. Although imaging evidence of venous obstruction may be present in approximately 25% of patients, symptoms are reported in only 1–3% of cases. Superior vena cava (SVC) syndrome is a rare presentation of central venous obstruction in patients with CIED. We report on the use of a combined approach of percutaneous laser lead extraction followed by venoplasty as a method for treating this problem. This approach led to resolution of the patient’s symptoms and allowed for reimplantation of another transvenous device. This report highlights the issue of central venous obstruction in patients with CIED and the important role of lead management with interventional procedures such as lead extraction and vessel dilatation.

KEYWORDS. central venous occlusion, superior vena cava syndrome, permanent pacemaker.

Case report

A 71-year-old patient was referred for evaluation of facial fullness and swelling of both upper extremities. She had a history of bilateral breast cancer. In 1996 she underwent a right mastectomy, followed by a left mastectomy in 2002. Following each procedure she received a course of intravenous chemotherapy but did not receive radiation therapy. In 2004 she had a transient ischemic attack and was placed on oral warfarin. She has had no further neurologic events. In 2005 she underwent implantation of a dual-chamber pacemaker using the left subclavian vein for venous access. St. Jude Medical (St. Paul, MN) 1388T active fixation leads were utilized for both atrial and ventricular pacing. There were no complications associated with the implantation procedure. Five years later, in December 2010, she presented to the office with a 6-month history of increasing symptoms of facial fullness and upper extremity swelling. Her facial fullness became more bothersome whenever she would bend over to tie her shoes or pick up an object.

A computed tomography (CT) scan of the neck and chest demonstrated an enlarged left jugular vein, suggesting collaterals from probable central venous occlusion. There were prominent cross-cervical collateral channels as well as prominent internal mammary and azygous veins, suggesting stenosis of the SVC. There was no evidence of hilar lymphadenopathy or pulmonary lesions suggesting metastatic disease.

Bilateral peripheral venography was then performed. Injection of contrast into a left peripheral vein demonstrated stenosis of the left brachiocephalic vein (Figure 1). Injection of contrast into a right peripheral vein demonstrated a significant stenosis of the SVC (Figure 2).

Removal of her pacing leads and pulse generator were then performed. Lead extraction was performed utilizing a 14 F Spectranetics (Colorado Springs, CO) laser sheath along with #2 lead locking devices. Both leads were easily extracted without complication. Two days following extraction of her pacing leads and removal of her pulse generator she returned for...
venoplasty of the SVC. Using the femoral approach, a long guidewire was passed through the SVC obstruction and into the right brachiocephalic vein. A pigtail catheter was then placed into the SVC for a post-lead extraction venogram (Figure 3). A residual SVC stenosis was present. The SVC was dilated to 5 atm using a 14-mm balloon with a small to moderate balloon waist that was completely effaced by balloon expansion (Figure 4). A post-procedure venogram demonstrated moderate improvement in the SVC stenosis with some residual narrowing that varied in appearance with respiration (Figure 5).

Four days later the patient returned for placement of a single chamber AAI pacemaker via the right subclavian vein. Her clinical course following the procedure was uncomplicated. Over the next month she reported complete resolution of her symptoms. There was a visible decrease in her facial fullness and she no longer reported swelling of her hands or fingers.

Figure 1: Left peripheral venogram: demonstration of central vein stenosis (arrow) with collaterals.

Figure 2: Right peripheral venogram: demonstration of superior vena cava stenosis (arrow).

Figure 3: Central venogram demonstrates residual superior vena cava stenosis following percutaneous lead extraction (arrow).

Figure 4: Venous angioplasty.

Figure 5: Venous angioplasty with improved flow in the SVC.
Central venous occlusion or stenosis may occur following implantation of leads for permanent pacing or defibrillation. A Symptomatic SVC syndrome is an unusual complication of CIED implantation but requires intervention for relief of symptoms. This problem is likely to become more prevalent as patients require more leads due to failure of previously implanted leads or upgrade to more complex CIEDs such as implantable cardioverter-deﬁbrillators or cardiac resynchronization devices. In addition, more patients, such as the one presented in this case scenario, need central venous access for long-term administration of intravenous medication such as chemotherapy or antibiotics. Percutaneous central venous catheters are also associated with a high incidence of central venous stenosis or thrombosis. Management of symptomatic central venous occlusion will, therefore, become an increasingly important clinical issue. Our case illustrates a percutaneous interventional approach to improve symptoms and allow for continued transvenous pacing as an alternative to surgery.

It is estimated that up to 25% of patients who receive CIEDs will have central venous obstruction, usually at the venous access site. Risk factors for occlusion include number of leads, patient age, history of thrombosis, hormone therapy, and absence of anticoagulation. The time course for the development of symptomatic central venous occlusion is variable. Whereas thrombosis in the access vein may occur soon after implantation, it may take months or years for more significant central venous occlusion, such as SVC syndrome, to occur. Anticoagulation is the first step in therapy, as many of these patients will become asymptomatic as collateral channels develop. However, as in this case, patients may develop significant symptoms despite warfarin and require intervention for treatment.

Resolution of the symptoms associated with SVC stenosis requires expanding the venous channel that has been narrowed by the presence of local fibrosis and/or thrombosis surrounding pacing leads. The trigger for this response is not known. However, in this case, previous insertion of multiple central venous catheters for administration of chemotherapy may have caused local vessel wall damage or irritation leading to fibrosis. Our patient also had bilateral breast cancer, but no radiation therapy. Hypercoagulable states associated with tumors or previous chest radiation may also be associated with SVC syndrome. Potential interventional approaches to relieve SVC stenosis include thrombolysis, venoplasty with or without the leads in place, stenting, and surgical reconstruction of the vein. In our case, management of SVC syndrome associated with pacing leads utilized a sequential, percutaneous, interventional approach of lead extraction, followed by vessel dilatation, and reimplantation.

Our technique involved lead extraction utilizing a laser sheath. The safety of percutaneous lead extraction is well established. Central venous occlusion does not appear to affect the efficacy of lead extraction. Once the leads are removed, the venous channel is enlarged, but significant venous stenosis may remain. Venous stenosis may then treated with venous angioplasty or stent placement followed by reimplantation of a permanent pacing lead. We chose not to dilate the SVC with the pacing leads in place. Since the etiology for SVC stenosis includes intimal ﬁbrosis surrounding the pacing leads, venoplasty with the leads in place would expand normal existing vein but do nothing to the area of vein where there is intimal ﬁbrosis. Although venoplasty with the leads in place would certainly improve the venous channel acutely, long-term patency remains a concern. Placement of self-expanding stents in the central veins is avoided when possible, as it may add signiﬁcant technical difficulty to subsequent venous access procedures if there were infection or lead malfunction. Stenting of the vein with the leads in place is contraindicated since it would “jail” the leads, making it impossible to percutaneously remove the leads in the future. Removal of the leads with subsequent venoplasty and reimplantation is a safe approach with a strong likelihood for long-term vessel patency. Long-term patency of these vessels is unknown, but no studies have been able to demonstrate any improvement using stents compared with balloon angioplasty alone.

We chose to manage SVC syndrome with separate procedures: peripheral venography, percutaneous lead extraction, venoplasty, and pacemaker reimplantation. Although peripheral venography and percutaneous lead extraction could have been performed during the same procedure, we feel that it is important to delay central venoplasty to another time. Tearing of the SVC is a potentially catastrophic complication of percutaneous lead extraction. The risk of venoplasty immediately following laser ablation of lead binding sites in the SVC is not known. Reimplantation of a new pacing system

Figure 5: Post-dilatation venogram demonstrates improved superior vena cava caliber.

**Discussion**

Central venous occlusion or stenosis may occur following implantation of leads for permanent pacing or defibrillation. Symptomatic SVC syndrome is an unusual complication of CIED implantation but requires intervention for relief of symptoms. This problem is likely to become more prevalent as patients require more leads due to failure of previously implanted leads or upgrade to more complex CIEDs such as implantable cardioverter-defibrillators or cardiac resynchronization devices. In addition, more patients, such as the one presented in this case scenario, need central venous access for long-term administration of intravenous medication such as chemotherapy or antibiotics. Percutaneous central venous catheters are also associated with a high incidence of central venous stenosis or thrombosis. Management of symptomatic central venous occlusion will, therefore, become an increasingly important clinical issue. Our case illustrates a percutaneous interventional approach to improve symptoms and allow for continued transvenous pacing as an alternative to surgery.

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could certainly be performed immediately after successful venoplasty. However, in the interest of patient comfort, we chose to have the patient return the following day.

There have been previous reports of successful venous angioplasty for central venous occlusion associated with pacing or defibrillator leads.\(^1\)\(^{,}\)\(^3\)\(^{,}\)\(^6\) The clinical risk factors associated with central venous occlusion in these cases were not highlighted. Complex CIEDs, which require a larger number of leads, are being implanted with increasing frequency. Another important risk factor, which is usually not considered, may be the long-term placement of central venous catheters which are also associated with central vein obstruction.\(^7\) The prevalence of central venous obstruction following CIED implantation is an increasingly common problem that may require percutaneous interventional techniques for symptomatic relief such as described in this report.

References