Arteriovenous fistulae complicating cardiac pacemaker lead extraction: Recognition, evaluation, and management

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Transvenous pacemaker lead extraction has become a commonly performed procedure that is associated with a small but significant risk. We report two cases where lead extraction was complicated by arteriovenous fistulae between branches of the aortic arch and the left brachiocephalic vein. Presenting signs and symptoms included severe chest or back pain, persistent or copious bleeding from the venous puncture site, unexplained hypotension or anemia, superior vena cava syndrome, and signs of central venous hypertension or acute heart failure. One patient whose injury was not recognized immediately and who did not undergo repair died rapidly, whereas the other patient who was diagnosed quickly underwent successful repair. Immediate diagnosis with arteriography and rapid intervention with surgery or percutaneous techniques are indicated and may prevent mortality. (J Vasc Surg 2000;32:1225-8.)

Transvenous extraction of chronically implanted pacemaker leads has become an increasingly common procedure.[1] The chief difficulty in removing these leads is to free them from the encasing fibrotic tissue, which becomes increasingly dense over time.[1,2] Several sheaths have been developed to separate the leads from attached scar tissue allowing their removal.[1,2]

In general, a metal or plastic polymer sheath is advanced over the lead to be removed with the careful application of sufficient traction to allow appropriate scar lysis without vein wall injury.[1] Recently, the excimer laser (Spectranetics Inc, Colorado Springs, Colo) has been applied in pacing lead extraction.[2] This XeCl laser produces pulsed ultraviolet light, which is delivered through fiber optics to the end of a flexible 12-, 14-, or 16-French sheath. The laser energy is absorbed within 100 μm, which allows for precise ablation of only that tissue located immediately in front of the sheath tip. In a recent multicenter trial, the laser sheath successfully removed 94% of the leads, compared with 64% of leads randomized to nonlaser techniques, without an attendant increase in morbidity or mortality.[2]

These techniques are effective, but they are associated with a 1% to 2% risk of serious complications such as myocardial avulsions, hemopericardium and cardiac tamponade, pulmonary embolus, and hemothorax.[1-3] Most of these complications resulted from difficulties freeing the electrode from the surrounding scar tissue, and they occur as the sheath is advanced over the lead or when excess traction is applied to the lead. These maneuvers can cause laceration to the wall of the vein or to the myocardium.

Venous laceration has been reported after pacemaker lead extraction, but injury to the great vessels and arteriovenous fistulae are not known complications.[1-3] We report two cases of arteriovenous fistula between aortic arch branches and the left brachiocephalic vein that occurred after pacing lead removal with the excimer laser.

CASE REPORTS

Case 1. A 49-year-old woman underwent removal of three pacemaker leads placed through the left subclavian vein and replacement of the pacemaker with a single ventricular lead. The leads were extracted in the cardiac electrophysiology suite under fluoroscopic guidance with

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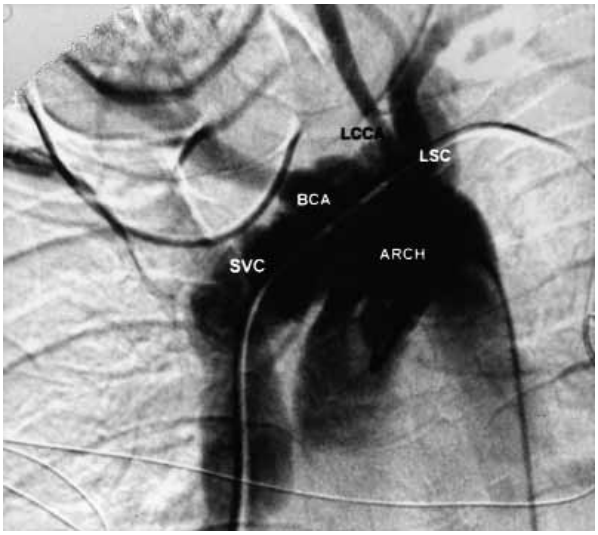

Fig 1. An arteriogram demonstrating brisk filling of the superior vena cava (*SVC*) through the left brachiocephalic vein during an arch injection. The newly placed pacing lead can be seen coursing through the left brachiocephalic vein and the SVC. *BCA,* Brachiocephalic artery (innominate artery); *LCCA,* left common carotid artery; *LSC,* left subclavian artery.

locking stylets, traction, nonpowered telescoping sheaths, and an excimer laser–powered sheath (Spectranetics Inc, Colorado Springs, Colo). All three leads were removed without apparent difficulty, although bleeding around the sheath was a bit more brisk and bright red than usual.

Immediately after the procedure, the patient had cyanosis and hypotension. Examination revealed good breath sounds bilaterally and no new cardiac murmurs. Despite apparent cyanosis, her oxygen saturation was measured at 93% by pulse oximetry. A surface echocardiogram showed no pericardial effusion or cardiac insufficiency. The clinical service believed that the patient had developed superior vena cava syndrome and treated her with oxygen, heparin, and an upright posture. The patient markedly improved with these measures, and she was admitted to the medical intensive care unit for observation. Six hours after the procedure, a chest radiograph revealed pulmonary edema, a widened mediastinum, and a large left pleural effusion.

The following day a new continuous murmur over the left prepectoral region prompted an arteriogram, which revealed a communication between the innominate artery and the left brachiocephalic vein (Fig 1). In addition, a tight stenosis at the junction of the superior vena cava to the atrium was noted. At this point the cardiac and vascular surgical services were consulted. The presence of cyanosis was worrisome, and it suggested the possibility of a right-to-left intracardiac shunt. Therefore, a transesophageal echocardiogram was recommended before surgery to exclude this possibility. During the procedure tachypnea and hypotension developed in the patient; then she had cardiopulmonary arrest and could not be resuscitated. At autopsy, the patient was found to have ruptured the fistula and hemorrhaged into the mediastinum.

Case 2. A 68-year-old woman had a dual chamber pacemaker implanted 17 years ago in the left pectoral area connected with bipolar leads to the right ventricle and the right atrium through the left subclavian vein. She presented to the cardiac electrophysiology suite to have the pacemaker leads changed for repairs. Extraction of the wires was initially attempted using a traditional locking stylet and nonpowered sheath technique. When this failed, an excimer laser was used. While the laser was manipulated in standard fashion, arterial blood was noted to escape from around the sheath. The sheath was removed, and hemostasis was obtained with direct pressure at the lead insertion site. The procedure was terminated, and a vascular surgical consultation was obtained.

The patient complained of chest and back pain but remained hemodynamically stable. Emergent arteriography was performed, and a large arteriovenous fistula was revealed between the origin of the left common carotid artery and the left brachiocephalic vein (Fig 2). In addition, early filling of the brachiocephalic vein was seen with selective injection of the innominate artery, which suggested another fistula. With this finding, operative intervention was recommended.

While being prepped for surgery, the patient became hypotensive with a systolic blood pressure between 80 and 90 mm Hg. The airway was controlled, and lines were placed for resuscitation and hemodynamic monitoring. A pulmonary artery catheter demonstrated a hyperdynamic response with cardiac outputs in excess of 10 L/min.

A median sternotomy was performed to identify the injury. The left brachiocephalic vein had a large tear along its posterior surface, and this vein was ligated. Mobilization of the vein exposed a large tear in the anterior wall of the origin of the left common carotid artery and a smaller hole at the origin of the innominate artery. The innominate artery laceration was repaired with plegeted sutures. The origin of the left common carotid artery was oversewn, and an ascending aorta to the left common carotid artery bypass graft was constructed with 6-mm polytetrafluoroethylene (W. L. Gore, Flagstaff, Ariz).

The patient did well after the procedure. She was extubated on postoperative day 6 and was discharged home on day 10. She remained neurologically intact and had no sequelae from her injury.

DISCUSSION

The most common life-threatening complication after pacing lead extraction is myocardial perforation or avulsion, which results in cardiac tamponade.[1,2] Arterial injury and creation of arteriovenous fistulae are distinctly uncommon.[1-3]

To our knowledge only one other case of arterial injury occurring after lead extraction has been reported.[4] In that case, a 40-year-old woman underwent extraction and replacement of a dual chamber pacemaker located in the left pectoral area with a laser sheath. During the procedure, a large amount of blood leaked around the sheath. After the procedure, bleeding from the puncture site persisted and required a suture for control. A decrease in hemoglobin after the procedure prompted a series of investigations culminating in arteriography, which demonstrated that the left internal mammary artery (IMA) had been transected as it crossed the subclavian vein. A pseudoaneurysm created by the arterial injury communicated with the subclavian vein. The proximal IMA was embolized, and the distal artery was surgically clipped through a small intercostal incision.

This patient and the two from our report shared several common features. First, the presence of increased venous pressure can be observed by persistent bleeding from the puncture site. This may be the first warning sign of an arterial injury or an arteriovenous fistula. Second, severe chest and back pain was the first symptom experienced by both patients whose arterial injury arose from a branch of the aortic arch. Other signs of arteriovenous fistulae in these patients included symptoms of central venous hypertension that would appear similar to superior vena cava syndrome, pulmonary edema, hemothorax, a widened mediastinum, hypotension, and anemia.

The first patient we reported was not diagnosed or treated rapidly. She had pulmonary edema and died as a result of a cardiopulmonary arrest. The second patient presented first with arterial bleeding from the puncture site, which alerted the cardiologists to a potential vascular problem, and urgent arteriography and rapid surgical repair were successful.

The long-term placement of intravenous pacing leads causes an inflammatory response in the vein wall. This response makes the vein adherent to surrounding structures including adjacent arteries. The proximity of the left subclavian vein to the left subclavian artery and the IMA and of the left brachiocephalic vein to the origin of the innominate and left common carotid arteries makes these vessels potentially susceptible to injury when removing leads placed through the left subclavian vein. Conversely, the right subclavian and brachiocephalic veins are intimately associated with the right subclavian and distal innominate arteries, which place these vessels at risk during right-sided removal.

Arteriovenous fistulae are much more common with pacemaker insertion than removal, with an incidence of approximately 0.5%.[5] These usually result from inadvertent arterial puncture.[5,6] The natural history of these fistulae is quite variable.[6] Some close spontaneously, whereas others persist for years with or without clinical symptoms. Because most of these fistulae are clinically benign, management is often expectant. If they become symptomatic, percutaneous embolization or surgery may be performed.

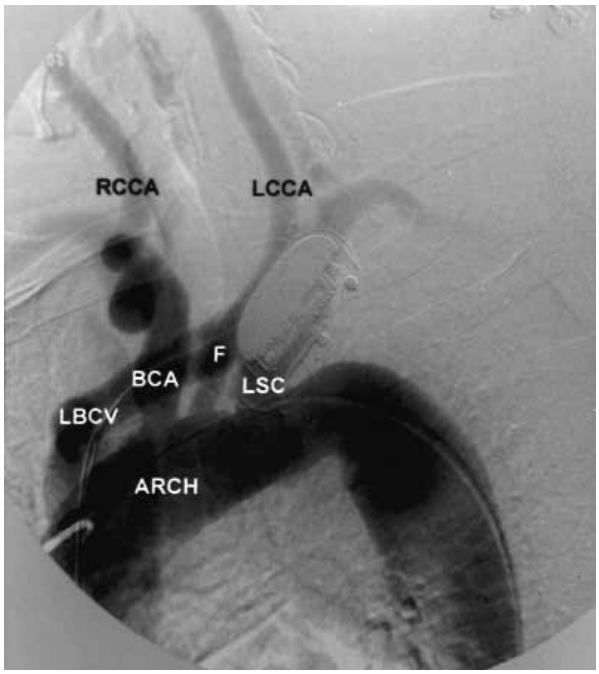

Fig 2. An arch aortogram demonstrating a fistula (*F*) between the origin of the left common carotid artery (*LCCA*) and the left brachiocephalic vein (*LBCV*). *BCA,* Brachiocephalic artery (innominate artery); *LSC,* left subclavian artery; *RCCA,* right common carotid artery.

We believe that fistulae that occur after pacing lead extraction do not mimic those that occur during insertion and more closely resemble traumatic injury. Trauma to the great vessels carries the highest mortality of any peripheral vascular injury.[7] These injuries can lead to rapid deterioration despite appropriate management, and mortality rates range from 5% to 30%.[7,8] It is well established that delays in diagnosis and management dramatically increase mortality from 2% to 4% in stable patients to 15% to 32% in those displaying hemodynamic instability.[7,8] These observations have led to the universal recommendation that injuries to the great vessels be evaluated and repaired rapidly.[7,8] There is no role for expectant management of stable patients with this diagnosis.

Recently, endovascular approaches have been

reported in the management of traumatic arterial injuries including pseudoaneurysms and arteriovenous fistulae.[9,10] Several covered grafts have been used including the Wallgraft, the Corvita endoluminal graft, and Palmaz stents covered with vein, polytetrafluoroethylene, or polyester. Covered stents allow for rapid repair of serious arterial injuries that may be located in sites difficult to access surgically. In the future these may be an appropriate treatment for not only arterial injuries after pacing lead extraction but for other arterial injuries as well.

CONCLUSION

Arteriovenous fistulae after pacemaker lead extraction are rare but potentially fatal complications. The proximity of the subclavian and brachiocephalic veins to the origin of the branches of the aortic arch makes these vessels especially prone to injury. Severe chest or back pain, persistent or copious bleeding from the puncture site, unexplained hypotension or anemia, and signs of acute heart failure should alert the clinician to the possibility of an arteriovenous fistula or arterial injury. Immediate arteriography and intervention with percutaneous techniques or surgery may be lifesaving.

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