Case Report

Massive Arm Edema Following Arteriovenous Dialysis Shunt Creation in a Patient With Ipsilateral Permanent Pacemaker

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ABSTRACT: Asymptomatic subclavian vein occlusion following insertion of a permanent pacemaker (PPM) or implantable cardioverter-defibrillator (ICD) is not uncommon. We report a case of a dual-chamber PPM in a patient with an unrecognized left subclavian vein occlusion who developed massive left arm edema following ipsilateral implantation of an arteriovenous (AV) hemodialysis graft. We recommend that patients with pre-existing PPM or ICD leads who are in need of vascular access for hemodialysis should have the AV shunts placed in the contralateral arm. If this is unavoidable, then preoperative subclavian vein screening for patency should be mandatory, even in asymptomatic patients. Sonography is an appropriate initial test in such a situation. © 2007 Wiley Periodicals, Inc. *J Clin Ultrasound* **36**:321–324, 2008; Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/jcu.20405

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Subclavian vein occlusion is not uncommon after insertion of permanent pacemakers (PPMs) or implantable cardioverter-defibrillators (ICDs). The majority of patients remain asymptomatic because they develop collateral circulation. However, if venous blood flow increases significantly—as occurs in patients with an ipsilateral arteriovenous (AV) shunt—then arm edema, pain, and functional impairment may occur. We report a case of a dual-chamber PPM in a patient who developed massive left arm edema following implantation of an AV hemodialysis graft. Sonographic examination revealed a previously unrecognized subclavian venous thrombosis along the path of the PPM leads.

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CASE REPORT

A 69-year-old man with normal cardiac function but with systemic hypertension, adult-onset diabetes mellitus, PPM for complete atrioventricular block, and stage IV chronic kidney disease presented with recent left arm swelling. A few weeks prior to presentation, a polytetrafluoroethylene loop graft connecting the brachial artery to the brachial vein was placed in the left forearm. The patient also reported that a dual-chamber pacemaker had been implanted via the left axillary/subclavian vein 5 years earlier.

On presentation, the patient's left arm was almost twice the size of his right arm (Figure 1) due to massive subcutaneous edema (Figure 2). Venous sonographic examination of the left upper extremity revealed pacemaker leads entering the left axillary vein (Figure 3) and extending into the left subclavian and brachiocephalic veins. There were signs of chronic thrombosis in all 3 veins (Figure 4). An enlarged left external jugular vein (Figure 5A) and a prominent left-to-right jugular venous arch were visualized; both were indicative of development of collateral venous circulation (Figure 5B). Because of the loss of left

FIGURE 1. Massive left arm edema following AV graft placement in a patient with pre-existing ipsilateral permanent pacemaker leads.

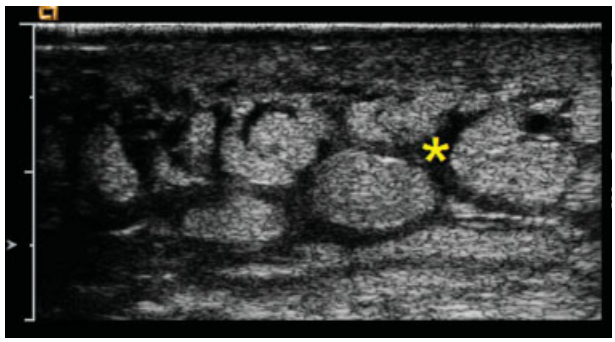

FIGURE 2. High-resolution sonogram of left arm subcutaneous tissue shows large areas of interstitial edema (asterisk).

hand function, the patient's left arm AV shunt was surgically ligated, and a new shunt was created in the contralateral arm.

DISCUSSION

Numerous reports of venous complications (including thrombosis, stenosis, and superior vena cava syndrome) following transvenous pacemaker or ICD lead placement have been published.[1] The reported prevalence of venous complications varies with the study population and ranges from 30% to 64%.[2–4]

In most studies, venous complications are clinically silent in the vast majority of patients.[2,3,5] For instance, Da Costa et al.[2] followed 202 patients after their first implantation of a permanent pacemaker lead. Six months after implantation, the authors observed venous lesions (ie, stenosis or thrombosis) via digital subtraction venography in 64% of patients. However, only 5.2% of patients developed clinical manifestations: 2.6% had upper extremity edema ipsilateral to the pacemaker implant, and 2.6% had pulmonary embolism.[2]

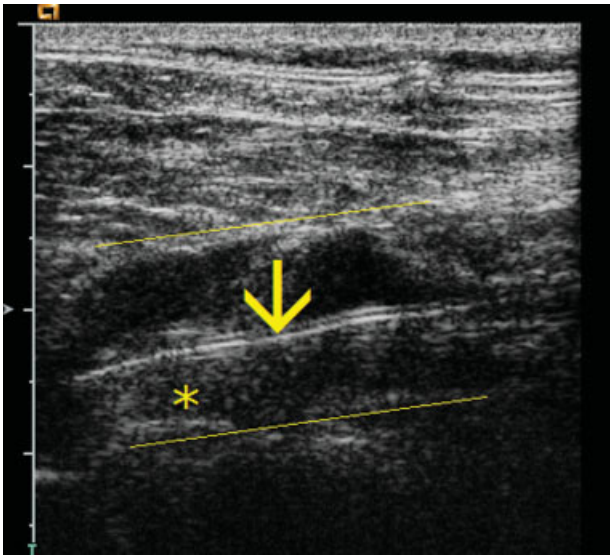

FIGURE 3. Gray-scale sonogram of the left subclavian vein (straight lines) shows a pacemaker lead (arrow) surrounded by intraluminal thrombus (asterisk).

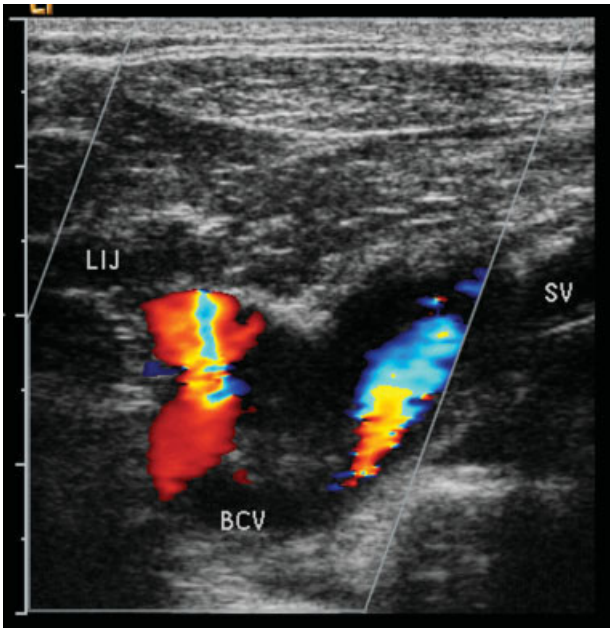

FIGURE 4. Color Doppler sonogram shows the confluence of the left internal jugular vein (LIJ) and the left subclavian vein (SV). A large amount of thrombus extending from the subclavian vein into the brachiocephalic vein (BCV) is depicted as a filling defect surrounded by residual color Doppler flow.

Our patient likely developed left upper extremity venous thrombosis after the implantation of his PPM. The venous obstruction was clinically silent as long as the amount of venous blood returning from the left arm was normal. After the implantation of the AV graft, the arterial

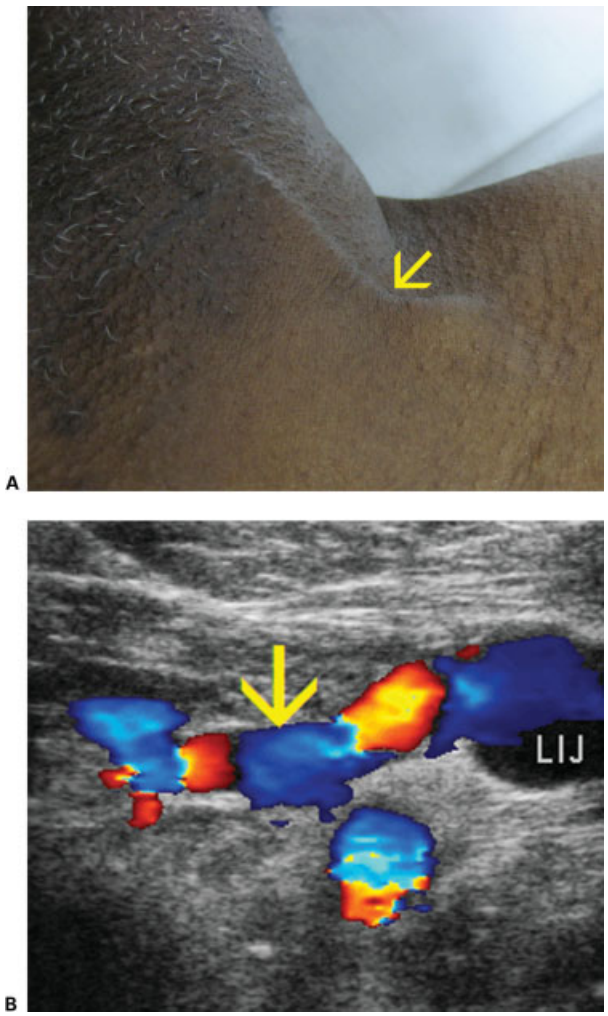

FIGURE 5. Development of collateral circulation. **(A)** Dilated left external jugular vein (arrow). **(B)** Color Doppler sonogram shows an unusually dilated jugular venous arch (arrow) directing the venous blood from the left to the right side of the neck. LIJ, left internal jugular vein.

inflow—and, consequently, the venous outflow—increased significantly. This increase in venous return overwhelmed the collateral circulation around the obstruction, leading to massive left arm edema and markedly impaired left hand function.

Blood flow to the arm typically increases after fistula formation due to the flow-mediated response. The artery enlarges over time, and the flow is dramatically increased—as is seen by the marked elevation of peak systolic and end diastolic velocities, as well as the disappearance of the reverse flow component on Doppler imaging. Patients with dialysis access shunts may develop mild to moderate swelling in their arms even in the absence of central vein stenosis; the edema becomes massive only when central vein stenosis or occlusion is present.

To our knowledge, there have been 21 reported cases of arm edema developing in patients with a hemodialysis AV shunt and an ipsilateral PPM. In a series of 10 such patients, ligation of the hemodialysis access was necessary to control their symptoms.[6] There are also reports of venoplasty and stenting of the stenosed segment with varying success, as well as jump grafting to the contralateral internal jugular vein. Consequently, this is a serious undertaking for all hemodialysis-dependent patients, because they are at risk for AV access site exhaustion.

Previous authors have recommended performing phlebography before AV shunt creation to detect pre-existing venous stenosis.[7] Although sonography has a very high sensitivity and specificity for diagnosing upper extremity deep venous thrombosis, we are unaware of any previous reports in which sonography has been used to diagnose venous thrombosis in patients with an ipsilateral PPM and AV shunt. Sonographic examination of the subclavian vein is relatively easy; it is performed by placing the transducer under the clavicle to see the union of the axillary and cephalic veins and therefore the distal part of the subclavian vein. The proximal part of the vein is imaged by placing the transducer above the clavicle. The union of the internal jugular and proximal subclavian vein is seen by imaging the former vein until its confluence with the latter.

The vein segment located under the clavicle is the most difficult to image. In our center, we place the transducer on top of the clavicle in an oblique fashion to follow the course of the subclavian vein. From this window, the subclavian vein is easily seen just before and after the clavicle. It is easy to demonstrate stenosis under the clavicle, because the highest velocity is seen at the exit of the stenosis, which is just after the clavicle. Sonographic criteria for central vein stenosis have been developed at our center by comparing it with pressure difference across stenosis, biplanar venography, and intravascular sonography.[8] Fibrous tissue is also easily recognized with sonography, because its acoustic impedance is very high (ie, very stiff and dense). The old thrombus appears the same way, because when it is not recanalized it is transformed into fibrous tissue. Both the old thrombus and fibrous tissue are more echogenic than the acute and subacute thrombus. Venography cannot distinguish between the two, and only intravascular sonography is superior to conventional sonography in this matter.

As the dialysis population becomes older and the proportion of patients needing pacemakers grows larger, one may predict that the problem

described in this report will become more frequent. We thus recommend that preoperative evaluation of the venous system be mandatory in any pacemaker patient before the first vascular access operation, and that whenever possible AV shunts be placed contralateral to PPM/ICD leads.

If ipsilateral placement is unavoidable, then diligent preoperative screening for venous occlusion along the path of the PPM or ICD leads is warranted. Because sonography is readily available and does not employ iodine contrast, it should be considered the initial test of choice in this patient population.

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