Transvenous cardioverter-defibrillator implantation with a double coil lead via persistent left superior vena cava

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A dual-coil defibrillation lead was inserted in a 64-year-old male through a persistent left superior vena cava draining into the coronary sinus. The lead, connected to a cardioverter-defibrillator (ICD) implanted in the left pectoral area, was looped in the right atrium positioning the proximal and distal lead coils in the coronary sinus and right ventricular outflow track respectively and resulting in a low and stable defibrillation threshold. Because of its relative ease and effectiveness, this procedure may be recommended in patients with persistent left superior vena cava requiring an ICD implant.

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Introduction

Persistent left superior vena cava is a congenital disorder seen in < 1% of the general population; it is more frequently associated with other congenital heart abnormalities, in particular atresia of the right superior vena cava[1,2]. Usually the left superior vena cava drains into the coronary sinus and it is mostly asymptomatic, its presence being occasionally found at catheterization of the left upper limb veins for cardiac pacing or other invasive procedures[2,3].

Current transvenous cardioverter-defibrillator (ICD) systems require the generator device to be implanted in the left pectoral area, and one or two defibrillation coils placed to encompass the largest left ventricular mass to optimize the defibrillation vector and lower the defibrillation threshold[4]. The anomalous course of a persistent superior vena cava could negatively affect the lead positioning, alter the direction of the vector and increase the defibrillation threshold. In the reported case, the defibrillation lead was positioned in such a way as to obtain surprisingly low defibrillation energies.

Case report

A 64-year-old male patient, with no previous history of myocardial disease, was admitted to the coronary care unit with acute pulmonary edema. Baseline ECG showed sinus rhythm with complete left bundle branch block. Two-dimensional echocardiography showed an enlarged left ventricle (end-diastolic diameter 61 mm) with anterior-apical akinesis and a severely depressed left ventricular function (ejection fraction 30%). No other significant structural abnormalities of the heart were found.

Markers of myocardial necrosis were within normal limit and so an acute myocardial infarction was excluded. Angiography documented a 70% proximal stenosis of the left anterior descending and occlusion of the right coronary artery. A rest-redistribution thallium-201 tomoscintigraphy showed a severe fixed perfusion defect in the antero-septal segments and apex. A coronary angioplasty of the left anterior descending was considered as not useful due to the large anterior necrosis found at the echo and nuclear imaging techniques. The right coronary artery was presumed chronically occluded and hence untreatable by coronary angioplasty. The risk-benefit ratio of right coronary artery bypass was considered unfavorable.

After 2 months, while the patient was being treated with ACE-inhibitors, diuretics, aspirin and carvedilol multiple asymptomatic runs of non-sustained ventricular tachycardia (the longest lasting 7 beats) were recorded during Holter monitoring. The patient was hence diagnosed as having

severe left ventricular dysfunction (not suitable for revascularization) without symptoms of heart failure (NYHA class II) and episodes of non-sustained ventricular tachycardia.

An ICD implant was planned.

Cannulation of the left subclavian vein was difficult, and venography from a peripheral left arm vein showed a subclavian vein in a cranial position, passing at an acute angle into a left superior vena cava and draining into the coronary sinus. On venographic examination from the right upper arm, the right subclavian vein was found in a cranial position, draining at an acute angle into a right superior vena cava confluent with the right atrium.

A passive fixation dual-coil lead (Endotak Reliance model 0148, Guidant Corp., St. Paul, MN, USA) was introduced through a 10.5F peel-away sheath into the left superior vena cava and advanced through the coronary sinus into the right atrium. A stylet was manually shaped to allow the creation of a wide loop in the right atrium, in order to advance the tip of the lead into the basal right ventricular outflow tract and place the proximal lead coil at the confluence of the left superior vena cava with the coronary sinus (Figs. 1 and 2). Sensing, pacing threshold and pacing impedance parameters were found to be acceptable (13 mV, 0.4 V and 453 Ohms, respectively), and the lead was connected to a generator (Contak Renewal II model H155, Guidant Corp.) implanted in the left pectoral area. The choice of a biventricular ICD device was made in order to allow future upgrading to a biventricular pacing system with the positioning of a new coronary sinus pacing lead if the clinical status of the patient necessitated this kind of pacing therapy.

Under general anesthesia (propofol 80 mg i.v.), ventricular fibrillation was twice induced and terminated with a 17 J shock. The total procedure time was 80 min and the fluoroscopy time was 9 min.

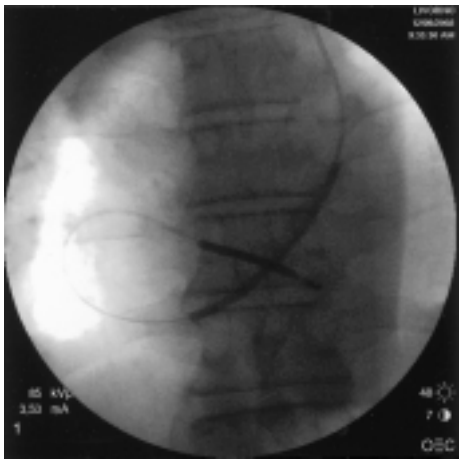

Figure 1. *Postero-anterior radiographs of the chest. The picture shows the lead performing a large loop in the right atrium and the position of the tip in the basal right ventricular outflow tract.*

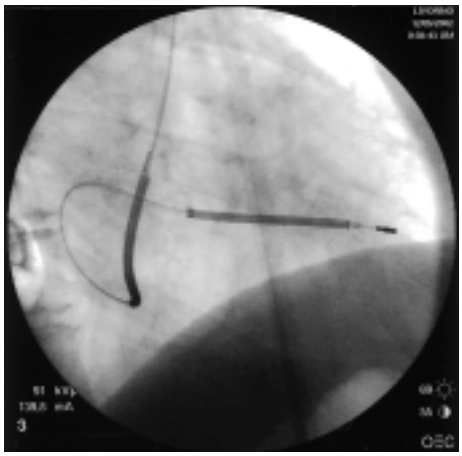

Figure 2. *Right anterior oblique radiographs of the chest. The right oblique view shows the proximal lead coil at the confluence of the left superior vena cava with the coronary sinus.*

At 1-month follow-up, chest X-ray showed a stable position of the lead within the right cardiac chambers. The right ventricular pacing threshold and sensing values were unchanged.

Discussion

A persistent left superior vena cava system is very uncommon. In our experience, among 780 consecutive patients in whom new cardiac stimulation/defibrillation leads were inserted in the last 3 years, we found only 4 cases (0.5%) with a persistent left superior vena cava: this prevalence is in agreement with that reported in other articles[1-3]. In these patients, cannulation of the subclavian vein is difficult, due to its anomalous cranial course behind the clavicle. It is therefore advisable to perform a left arm venography in case of particularly difficult percutaneous subclavian venipuncture, to exclude the presence of such an anomaly.

Although rarely found during invasive procedures, a persistent left superior vena cava challenges the electrophysiologist, who deals with rather firm leads that have been designed for a normal upper limb venous anatomy. In this case, catheter handling is limited due to the altered venous course, and its stability within the right ventricle may be affected, particularly in case of a less compliant dual coil defibrillation lead. Moreover, the anomalous course of the lead in the right atrium determines a defective alignment in the right ventricle.

Low defibrillation energy thresholds is the primary goal for a successful ICD implantation and depends on a variety of critical factors; among these, optimal lead placement through the preferable left approach[4] is the difficult target to be reached in the presence of a persistent left superior vena cava[5].

Previous reports showed that despite these difficulties, successful ICD implant could be achieved[2,6-8]. In the first report, an abdominal ICD was connected to a single

coil endocardiac lead introduced into the right ventricle through the left superior vena cava; the addition of a subcutaneous patch on the left side of the chest was needed to lower the defibrillation threshold[6]. Favale et al.[7], illustrated a similar case with the difference of a pectoral instead of an abdominal ICD implantation.

The right subclavian vein approach was used in 2 cases: in the first case, the ICD was placed in the right pectoral area[2] while in the second case the lead was connected to a left-sided implanted ICD through a long subcutaneous connector[7].

Again, a left approach was reported in 2 different patients: for one of them only anatomical information are available[2]; for the other a single coil lead was used together with an "active can" device but the defibrillation threshold was however very high (24 J)[8].

To ensure a lower threshold and gain a more "flexible" defibrillation system in our patients, we opted for a dual coil defibrillation lead; to optimize the defibrillation pathways, however, we choose an unusual coil orientation. In an attempt to increase the energy distribution to the left ventricle, we placed the proximal and distal coils in the coronary sinus and right ventricular outflow tract, respectively[9,10].

In summary, our report illustrates the feasibility of placing, in a patient with a persistent left superior vena cava, a dual coil-active can system and achieving very low defibrillation thresholds. This procedure did not require an additional subcutaneous patch nor a right-sided lead tunneled to the left subclavian area and yet allowed a defibrillation threshold < 17 J, well within the safety limits for this type of ICD device.

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