Active fixation of bipolar left ventricular lead through a persistent left superior vena cava

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We illustrate a particular case of cardiac resynchronization therapy with defibrillation function device (CRT-D) in a patient with persistent left superior vena cava (PLSVC).

This 61-year-old man had undergone an atrial septal defect closure in young age and then an edge-to-edge mitral repair; later, he also underwent a mitral valve replacement with a mechanical prosthetic valve. Coronary arteries were previously investigated and no injuries or stenoses were found.

Recently, the patient was admitted for a left ischemic cerebellar stroke caused by paroxysmal atrial fibrillation; during the hospital stay, a severe reduction of left ventricular ejection fraction (LVEF) was detected.

After a negative coronary angiography the patient was referred for CRT-D implantation because LVEF was still severely decreased despite the optimal medical therapy (maximum titration of angiotensin-converting enzyme inhibitors, beta-blockers, diuretics, antialdosteronics), according to the current guidelines. When admitted to hospital, the patient was asymptomatic with a good hemodynamic state. The ECG showed a left bundle branch block. The echocardiogram showed a left ventricular dilation (end-diastolic volume: 100 ml/m²) with widespread hypokinesis and severely reduced LVEF (32%). The left atrium was severely dilated.

Once left subclavian vein puncture was performed, the first guidewire immediately followed an abnormal path inside the heart, driving along the left heart side instead of the right one. The other two guidewires (a total of three punctures were performed) followed the same path. Contrast dye injection confirmed a left superior vena cava persistence (Figure 1).

At first, an active defibrillation single-coil lead (Sprint Quattro Secure, 62 cm; Medtronic) was placed: once advanced...
through the left superior vena cava it was necessary to shape the stylet with a "pigtail" curve in order to get through the tricuspid valve and push it on the right ventricle's wall, screwing it on a low-apical interventricular septum, as shown in Figure 2A,B. A decapolar catheter was used as a landmark point to localize the tricuspid valve making the defibrillation lead placement easier (Figure 2B).

The coronary sinus was identified by small puffs of contrast dye injection directly through the superior vena cava (Figure 3A).

An active fixation bipolar lead (Attain Stability, 88 cm, Medtronic) was advanced through the sheath, reaching an antero-lateral coronary sinus branch, through a supportive guidewire (Zinger Medium, Medtronic) and by means of a sub-selection inner catheter (6248 V-130; Medtronic). Finally, the catheter was rotated clockwise for the active fixation (Figure 3B,C). The decision to implant a bipolar active fixation lead in the coronary sinus was due to the need of stability into the vessel's branch (Figure 3B,C). The implantation of an active fixation quadripolar lead had been unsuccessfully attempted; unfortunately, the branch was too small, the catheter was not stable and a good position was not achievable.

Specifically, the right atrial lead showed a sensing of 1.5 mV, a bipolar impedance of 750 Ohm and a threshold of 0.75 V x 0.4 ms. The right ventricular lead had a sensing of 6 mV, an impedance of 540 Ohm and a threshold of 1 V x 0.4 ms. The left ventricular lead showed a bipolar pacing impedance of 960 Ohm and a threshold of 1.75 V at 0.4 ms, therefore the output was set at 3.5 V@0.4 ms; no phrenic stimulation was observed even at the highest output.

FIGURE 2 (A) Right ventricular lead positioning (Right anterior oblique [RAO] 30° fluoroscopy). (B) Right atrial lead positioning (RAO 30° fluoroscopy). A decapolar electrophysiology catheter can be noticed; this catheter has been used as a reference point for tricuspid valve making the defibrillation lead placement easier.

FIGURE 3 (A) Contrast dye fluorography highlighting the coronary sinus directly draining into the left superior vena cava. (B) Left ventricular lead positioning inside an antero-lateral coronary sinus branch (Right anterior oblique 30° fluoroscopy). (C) The picture clearly shows the active fixation bipolar left ventricular lead and the marker behind the dipole which represents the active fixation helix (LAO 30° fluoroscopy)
The biventricular pacing resulted in a shortening of QRS duration from 130 to 110 ms (Figure 4A,B).

The final X-rays showed a good position of the three catheters; in particular, an adequate distance between right and left ventricular leads was achieved (Figure 3B).

A PLSVC is the most common systemic venous anomaly in the thorax with a reported prevalence of up to 0.5% in otherwise normal population and up to 10% in patients with congenital heart disease.2 It derives from jugular and subclavian vein junction, then descending parallel to the right superior vena cava (generally present in most of the cases), it is directly linked to the coronary sinus and to the right atrium through a smaller coronary sinus that flows into the main one.2 Although the patient underwent previous open-heart surgical procedures, no mention about PLSVC was found in the patient’s files (previous surgical interventions were performed in other centers and partial documentation was provided).

Although the PLSVC is a rare abnormality of the venous system, it is not so infrequent and the electrophysiologist should be prepared to face it. Such venous system implies a perspective change for the electrophysiologist: achieving optimal pacing sites becomes more complex, making the whole procedure more challenging. A few case reports have already described how to face this challenging anatomy.3–5 The present case specifically addresses the implantation technique providing tricks and suggestions to make the procedure safe and feasible.

As a matter of fact, it is not always easy and comfortable for the operator to place more than one catheter through this special venous anatomy, especially a biventricular device. In some cases, long sheaths might be needed to support the leads during the placement. A right-side approach can be also attempted, especially if the venous anomaly is already known before the procedure.

Nevertheless, those patients who present PLSVC and need CRT-D but the implantation is not successful, alternative techniques should be considered such as the surgical placement of epicardial leads.

CONFLICT OF INTEREST
No conflict of interest to be declared.

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