

How to Safely Implant a Dual-Chamber Pacemaker for Right Ventricular Outflow Tract Pacing in a Patient with Persistent Left Superior Vena Cava: A Step by Step Guide

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INTRODUCTION

The implementation of advanced endovascular electrophysiological methods in patients with congenital venous anomalies (CVA) remains understudied.¹ Patients with CVA have an average life expectancy. At times requiring interventional management of dysrhythmias, CVA can pose a challenge for the placement of implantable pacing devices. Persistent left superior vena cava (PLSVC) is the most common venous congenital anomaly. Herein the author discusses a safe technique of transvenous pacing lead implantation into right ventricular outflow tract (RVOT) and right atrial appendage in a 70-year-old patient with PLSVC.

CASE REPORT

A 70-year-old male with a history of nonsignificant coronary artery disease admitted with dyspnea on exertion and intermittent vertigo. The electrocardiogram demonstrated bradycardia at 47 beats per minute and second-degree atrioventricular block, with an atrial-to-ventricular conduction ratio of 2:1. In accordance with the 2013 European Society of Cardiology (ESC) Guidelines on cardiac pacing and cardiac resynchronization,²

the patient was taken for implantation of a permanent dual-chamber pacemaker. Access was initiated via a standard left subclavian approach, a common site of vascular access for such a procedure. However, it was noted that the initial guidewire did not take the anticipated course across the mediastinal midline but instead maintained a vertical downward trajectory along the left cardiac border. This recognition raised consideration of PLSVC. Therefore, a venogram was performed. Findings from the venogram confirmed PLSVC which was draining through the dilated coronary sinus (CS). First, via left subclavian vein access into the PLSVC and dilated CS, the lead-stylet assembly was carefully navigated to the ostium of the CS in the right atrium (RA), using a stylet shaped with a mild primary curve “hockey stick” shape (Figure 1A). Next, the stylet was removed, and an exaggerated primary curve was created to the point of a “pigtail-like” shape with a diameter of 3-4 cm. Then a secondary curve was bent at the end of the stylet up to 10 mm with a bend of 45-60 degrees and with slightly posterior angulation up to 20 degrees (Figure 1B). This double curved stylet was reintroduced completely into the lead. When the lead was then advanced into the RA, it assumed a wide “swan neck” shaped configuration representing flattening of the exaggerated coaxial pigtail which was initially created. With counter-clockwise rotation, this lead-stylet assembly was gently directed toward the tricuspid valve and the tip of this wide swan neck shaped lead-stylet assembly was pointing to the orifice of the valve. While the stylet was held in the RA, the floppy lead was easily wriggled through the orifice of the tricuspid valve aided by the blood flow into the right ventricle. Subsequently, the stylet was slowly moved forward until it was entirely reintroduced into the tip of the lead. With the lead-stylet combination now in

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a safe reverse-curved banked position, it was possible to feed the lead over the stylet toward the target RVOT. After inserting the right ventricle active-fixation lead in the RVOT, we measured the R-wave amplitude of 12 mV, and the threshold was 0.4 V at 0.4 ms. Next, in order to implant the right atrial active-fixation lead into the targeted right atrial appendage an in vivo target conformation of right-angled bending “hockey stick” shape, for

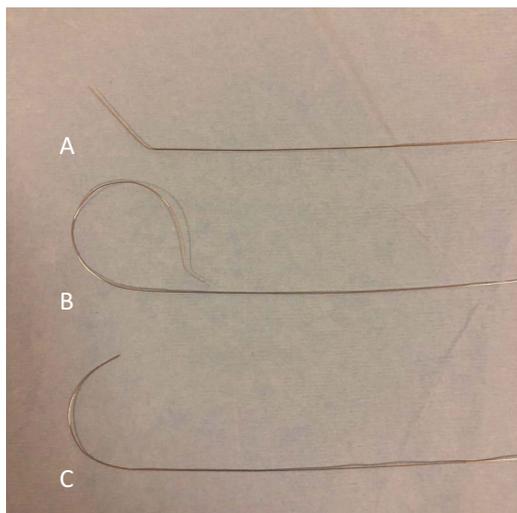


Figure 1. (A) Stylet shaped as “hockey stick” shape, (B) “pigtail-like” shape with a diameter of 3-4 cm and a secondary curve with a bent at the end of the stylet up to 10 mm with slightly posterior angulation but without acute-angled bending of 45-60 degrees, (C) stylet shaped as “J-shape”.

which an ex vivo primary curve of “J-shape” was introduced (Figure 1C). This right-angled hockey stick shaped lead-stylet conformation was steered toward the region of the right atrial appendage, and while the stylet was fixed at the bottom of the RA, the tip of floppy atrial lead pointing towards the right atrial appendage was forwarded and safely implanted into the right atrial appendage. Via the implanted right atrial lead we measured the P-wave amplitude of 3 mV, with a threshold of 0.8 V at 0.4 ms. Finally, both leads were connected to a dual-chamber pacemaker device. Posterior-anterior chest radiograph (Figure 2A) from post-interventional day 1 confirmed a stable position of the pacemaker implant with leads overlying their expected positions at the RVOT and right atrial appendage. During follow-up, cardiovascular imaging with multidetector computed tomography with cardiac gating was performed (Figure 2B) which confirmed the position of the right ventricular lead in RVOT and revealing a single PLSVC. Now, after a follow-up of 5 years, there were no lead displacement or fracture and device malfunction.

DISCUSSION

In patients with congenital anomalies of the great vessels, PLSVC represents the most common congenital

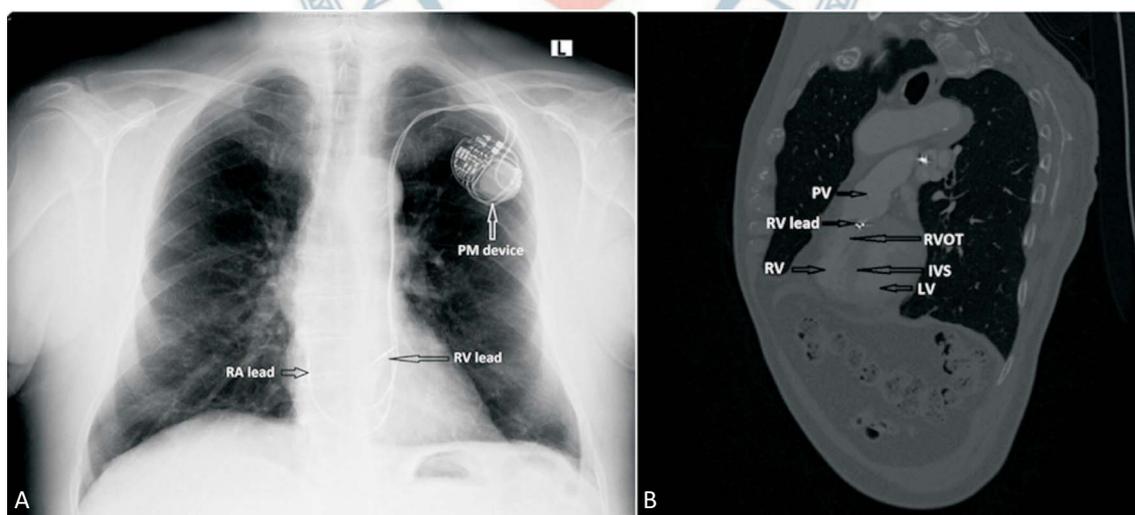


Figure 2. (A) Transvenous dual-chamber pacemaker implantation via left subclavian approach in a patient with persistent left superior vena cava. The chest x-ray revealed the course and the final placement of the right atrial and right ventricular leads through the persistent left superior vena cava. (B) Post-procedural multidetector CT scan with cardiac gating was performed. Oblique sagittal multiplanar reconstruction with a slice thickness of 0.86 mm from source images of 1 mm slice thickness using freeware Osirix software. In this image, only the RVOT lead is shown. CT, computed tomography; IVS, interventricular septum; LV, left ventricle; PV, pulmonary valve; RV, right ventricle; RVOT, right ventricular outflow tract.

anomaly of the thoracic venous system, with a prevalence of 0.56% in the general population and 2.9% in patients with other congenital cardiac anomalies.¹ A relatively high incidence of conduction disturbances requiring a permanent pacemaker in patients with PLSVC has been reported.^{3,4} Due to anatomical conditions, the increased incidence supposes to be correlated with both stretchings of the atrioventricular node and His bundle.⁴ Importantly, equipment selection determines the safety and success of this technique. The stylet comes in soft, intermediate-stiffness, and stiff options. Usage of a stiff stylet is not advisable during mediastinal venous interventions due to the risk of venous perforation which might lead to hemothorax, and during excessive manipulations to vector toward the RVOT which might result in tricuspid valve injury. Utilisation of the soft stylet is not advisable for three reasons: it does not accommodate the overshaping and loses too much curve upon reaching its in vivo endpoint, it reduces selectivity of the lead-wire coaxial combination, and reduces pushability and trackability when delivering the lead over-the-stylet toward the implantation target zone. Therefore, an intermediate-stiffness stylet is the correct selection when using this method. Finally, this technique allows delivery of a wide swan neck shaped lead-stylet combination toward the tricuspid valve without concern for valve injury.

However, using this hand-fashioned stylet technique to achieve RVOT pacing in patients with PLSVC and dilated right ventricle is only possible with a reasonable increase in the diameter (such as from 3-4 cm to 4-5 cm and possibly larger) of the "pigtail-like" shape. In case of right atrial dilatation, the diameter of J-shape should

also be increased appropriately.

LEARNING POINTS

The present report describes the tools and technical methods required to safely implant a dual chamber pacemaker for reliable RVOT pacing in a patient with persistent PLSVC.

DECLARATION OF CONFLICT OF INTEREST

The author declares no conflict of interest.

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