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Conduction System Pacing in a Patient with Persistent Left Superior Vena Cava and Absent Right Superior Vena Cava

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Abstract

Background: Physiologic pacing is increasingly used as an alternative when there is a failure in cardiac resynchronization therapy (CRT), with more challenging situations expected consequently.

Case Presentation: An 83-year-old Caucasian man underwent attempted CRT, but was found to have a persistent left superior vena cava (SVC) and absence of a right SVC. Additionally, no suitable coronary sinus (CS) veins were found. Instead, conduction system pacing with a modified approach was used.

Conclusions: The presence of left superior SVC is compatible with safe implantation of conduction system pacing, using conventional tools and with mild modification of typical technique.

Keywords: Conduction system pacing; Cardiac resynchronization therapy; Persistent left superior vena cava; Cardiology

Background

Physiologic pacing through His bundle or left bundle branch pacing is increasingly recognized as an alternative to cardiac resynchronization therapy (CRT). In absence of large randomized clinical trials, most recent pacing guidelines do not recommend such physiologic pacing in first line but as an alternative in case of failed left ventricular lead implantation.

Persistent left SVC may lead to left ventricular lead implantation difficulties or failure [1] and it can be found in 0.3 to 0.5% of individuals in the general population and in 4.5% of individuals with known congenital heart disease. The persistent left SVC usually drains to the right atrium (RA) through a dilated CS, and in approximately 10 to 20% of cases, can drain into the left atrium directly or through an unroofed CS. The right SVC, with or without an innominate vein connecting to the persistent left SVC, is present in the majority of cases, while a single left-sided SVC occurs in one third of subjects.

This anomaly is usually asymptomatic and unrecognized, but it may create a challenge when detected incidentally during central venous catheterization or cardiac device implantation, causing technical difficulties [2-5].

Case Presentation

An 83-year-old male with ischemic dilated cardiomyopathy with LV ejection fraction of 30%, NYHA class II heart failure despite optimal medical therapy, and QRS width of 154 ms with right bundle branch block (RBBB) morphology (Figure 1, top) was planned for CRT implantation. The final decision for CRT-P implantation instead of CRT-D was taken in multidisciplinary session considering patient's preferences and balancing risks and benefits.

Once left subclavian access was achieved, we noticed an unusual course of the guide wires. They descended along the left parasternal border, suggesting the presence of a persistent LSVC. Contrast injection confirmed drainage into a severely dilated CS ending into the RA (Figure 2, left). In addition, the absence of a right SVC was noted. We did not perform any additional venography from the right side due to the presence of a phlebitis in the right arm. Although, multiple failed attempts were made with a guide-wire in order to reach the RA.

A 58-cm active-fixation lead was placed in the low region of the free wall of the right ventricle outflow tract after passing through the CS, the RA and tricuspid valve. Subsequently a 52-cm active-fixation lead was placed in the lateral wall of the RA. Coronary sinus venography was then performed in order to find suitable coronary branches to deliver CRT. As no readily available balloon was large enough to allow complete occlusion of the CS a pre-shaped inner sheath (Medtronic 6248vi-90) was used, with contrast injection performed with pull back from the CS ostium until the persistent left SVC (Figure 2, right). No evidence of any coronary vein drainage into the main body of the CS was found. A decision was made to perform conduction system pacing in order to provide physiological pacing.

We advanced a 4F active-fixation lead (Medtronic Select Secure 69 cm) through its specific pre-shaped sheath (Medtronic C315HIS) into the RA. Then the lead was slightly pulled back into the sheath in order to enhance the curve, and subsequently the sheath and lead were advanced towards the tricuspid valve and rotated counterclockwise towards the septum (Figure 3, left). Due to difficulty identifying a His electrogram, we searched for His capture with pacemapping, obtaining a suboptimal stimulated QRS duration of 115 ms with myocardial capture [6] (Figure 1, middle), with a bipolar pacing output of 1,25*0,4ms. With higher outputs there was a non-selective capture which resulted in an even narrower QRS of 95ms (Figure 1, bottom).

The final parameters were capture threshold of 1,75V@0.4 ms for ns-His capture and absolute threshold of 0,75@0,4ms, an impedance of 823 ohms and R wave amplitude of 5 mV. The free wall ventricular lead that was placed before was not removed for safety reasons, since this was the first time that His lead had been placed through a persistent left SVC. The patient was discharged the day after the procedure and the first device follow-up at one month confirmed satisfactory electrical parameters. Figure 3, right shows the final position of the leads.

During the follow-up, an improvement was noted both in patient's functional class and in left ventricle ejection fraction, which increased from 30% to 41% at 12 months. Device interrogation showed a ventricular pacing burden of 100% and despite a tolerable high pacing threshold, there was good stability in all the parameters of the lead.

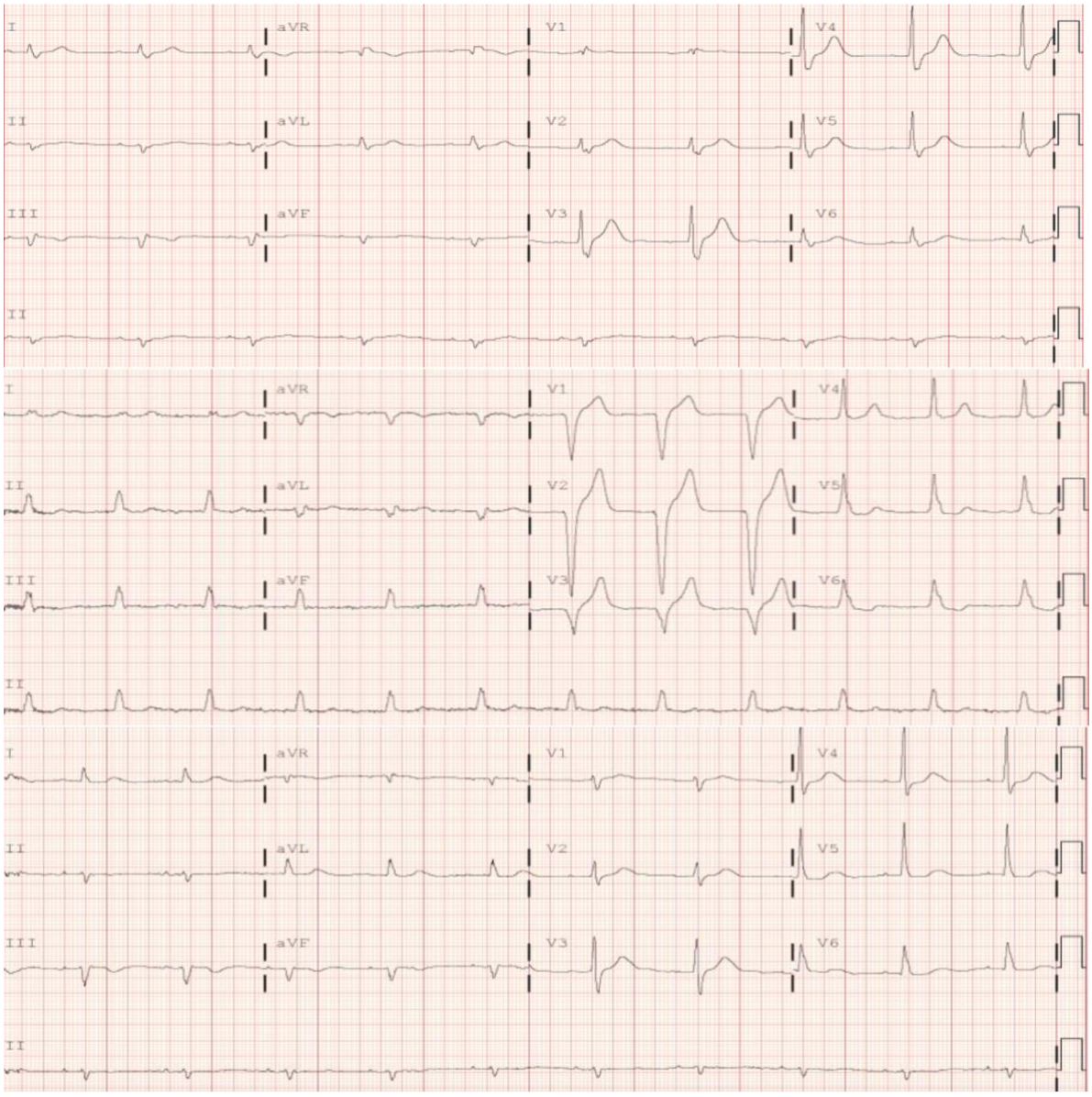

Figure 1: Top: Initial ECG, showing a RBBB morphology with QRS width of 154 ms and left anterior fascicular block. **Middle:** ECG at the end of the procedure. Pacemaker was programmed in DDD mode with a standard atrium to ventricle delay and only left ventricle (His lead) capture. **Middle:** ECG shows a fully stimulated QRS with lower outputs, there is suboptimal QRS duration of 115 ms length as a consequence of obtaining myocardial capture6 (demonstrated by the absence of isoelectric line between the spike and the beginning of the QRS, stimulus-V6RWPT>110 ms and a notch in V3 and the presence of a plateau in I and V6). **Bottom:** The ECG with higher outputs is showing a QRS duration of 95 ms with non-selective-His capture (absence of isoelectric line between the spike and the QRS, with little delta wave due to the absence of any notch or plateau and stimulus-V6RWPT<100 ms.

LBBB: Left Bundle Branch Block; RBBB: Right Bundle Branch; V6RWPT: V6 R-wave Peak Time

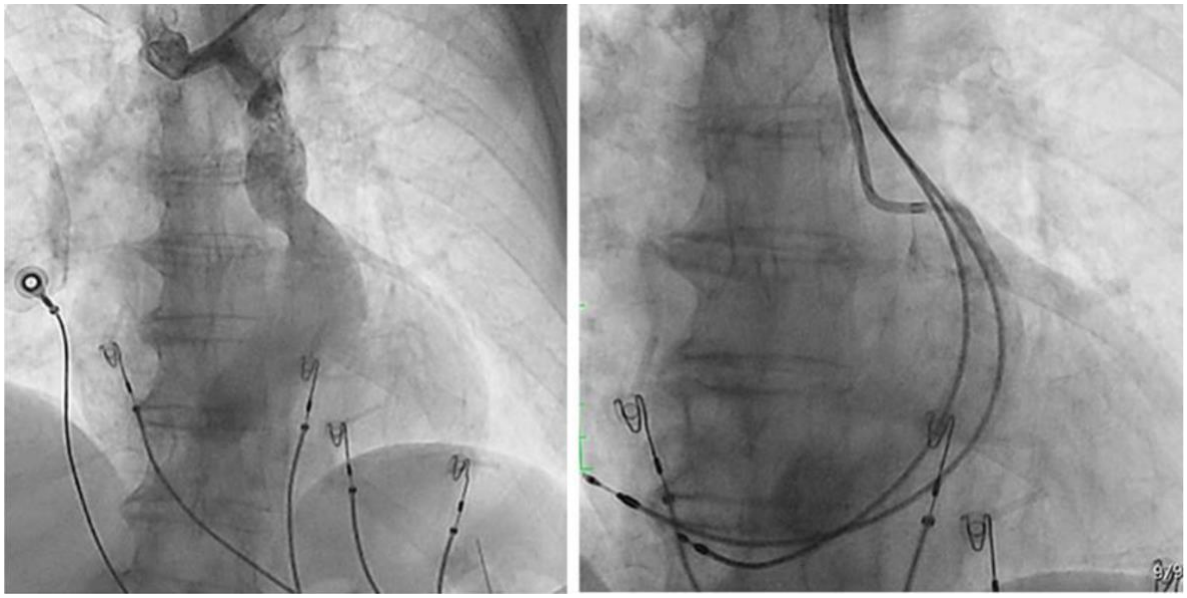

Figure 2: Left: Angiography AP projection displaying the presence of a Left Persistent SVC, draining into a severely dilated CS ending into the Right Atrium. Of note, normal Right SVC was absent. **Right:** Angiography AP projection showing contrast injection through the His implant specific pre-shaped sheath as operator pulls it back from the CS ostium until the Persistent Left SVC. No evidence of any coronary vein draining to the main body of the CS was noticed. Importantly no balloon was large enough to allow complete occlusion of the CS. **SVC:** Superior Vena Cava; **CS:** Coronary Sinus.

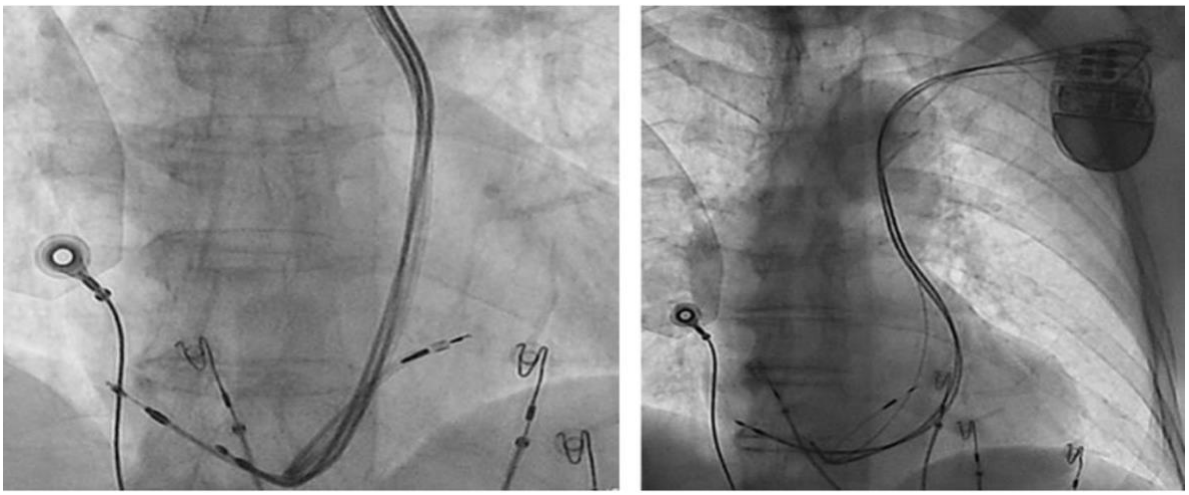

Figure 3: Left: Fluoroscopy AP projection during 4F active-fixation lead deployment. The lead was first pushed towards the tricuspid valve and then rotated in counter clockwise into the septum, as usually performed in regular His implants. **Right:** Final position of the leads.

Discussion

A persistent left SVC is an uncommon congenital anomaly, which can occasionally be encountered during rhythm cardiac device implantation procedures. The anatomic challenge presented in this case was successfully overcome using available tools to perform conduction system pacing. Performing CRT in patients with a persistent left SVC has particular challenges. Catheterization of the CS branches from the left side can be difficult due to abnormal outflows, unusual angles, and the absence of adequate support for the delivery system, as opposed to the access from the right side, where the branches are much more approachable. In addition, due to the severe dilatation of the CS, balloon occlusion is unlikely to be properly performed, resulting in suboptimal angiography. Despite reports of CRT device implantation procedures in patients with persistent left SVC [7-11], the evidence with His bundle stimulation in these patients is scarce. There is only one report from Bastian et al [12]. They performed the procedure in a patient with persistent left SVC but through a patent right SVC. Therefore, to our knowledge this is the first case describing physiologic stimulation from the persistent left SVC. Additionally, we want to emphasize that His bundle stimulation has shown promising results in RBBB patients [13-14]. In our case, we did not find any adequate venous branch to achieve resynchronization therapy, and additionally patient lacked of right SVC. For this reason, we attempted and successfully achieved physiologic stimulation using a specific His stimulation system (Medtronic sheath C315HIS, Medtronic lead SelectSecure 69 cm) with a more exaggerated clockwise and counterclockwise rotation movements compared with conventional technical manipulation in order to achieve conduction system capture.

Conclusion

This case highlights the potential to achieve physiologic stimulation in case of challenging venous access. In summary, the presence of persistent left superior SVC does not preclude safe implantation of conduction system pacing. With modification of the typical technique, conventional tools can be used.

Abbreviations: RA: Right Atrium; RBBB: Right Bundle Branch Block; LBBB: Left Bundle Branch Block; SVC: Superior Vena Cava; CS: Coronary Sinus; CRT: Cardiac Resynchronization Therapy; V6RWPT: V6 R-wave Peak Time.

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