

A right subclavian vein approach for interventricular septum puncture and left ventricular endocardial lead placement in cardiac resynchronization therapy



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Introduction

The number of heart failure patients who benefit from cardiac resynchronization therapy (CRT) devices, continues to increase around the world. Endovascular delivery of a lead into the coronary sinus (CS) is the most common approach to achieve left ventricular (LV) stimulation; however, it has a failure rate of 2.9%, mostly owing to coronary venous anatomy restrictions.¹ Moreover, there is a significant portion of patients who are not responders despite CS stimulation, and in whom CS cannulation is not possible after a previous lead extraction.² Normally, the next step to provide resynchronization in such cases is through a surgical procedure for epicardial LV implantation. However, such approach is associated with higher morbidity, difficulty to access optimal pacing sites, higher risk of lead dysfunction, and greater electromechanical delay.^{3,4} As such, novel techniques have emerged to provide LV endocardial stimulation, including implantation through an interatrial septum puncture, an interventricular septum approach,^{5,6} and, most recently, wireless stimulation.⁷ Recent studies have shown the superiority of endocardial stimulation in comparison to traditional CS pacing. In this clinical case, we will describe the implantation of an LV endocardial lead, using both fluoroscopy and intracardiac echocardiography (ICE) using a right subclavian vein puncture.

Case report

A 63-year-old man with a history of nonischemic dilated cardiomyopathy, LV ejection fraction (LVEF) of 27%, left

KEY TEACHING POINTS

- A right subclavian approach for intraventricular septal puncture and left endocardial lead placement is feasible.
- Coronary sinus vein placement for cardiac resynchronization therapy is not always possible.
- Intracardiac echocardiography is a useful tool for intraventricular septal puncture.

bundle branch block, New York Heart Association (NYHA) class III, who received a CRT-D device in 2011. He was identified as a super-responder, with an improvement in both his LVEF, to 46%, and his functional class, to NYHA I. In 2013, extraction of the CS lead was performed owing to dysfunction, and subsequent attempts at reimplantation were unsuccessful. Specifically, we were unable to find a suitable tributary for lead placement.

Follow-up of the patient showed a decrease of LVEF to 21% and deterioration of functional class to NYHA III. A decision was made to perform surgical LV lead implantation using the Da Vinci robotic system (Intuitive Surgical, Inc, Sunnyvale, CA); however, the procedure failed owing inadequate pacing thresholds.

As such, the case was assessed by our hospital's Heart Team, which decided in favor of endocardial LV lead implantation through an interventricular septum puncture. A venogram was performed prior to the procedure, showing lack of permeability of the left subclavian vein. A decision was made to attempt implantation through the right subclavian vein. After successful puncture of the vein, a 0.032-inch guide-wire and a steerable sheath (Agilis, St. Jude Medical, St. Paul, MN) were advanced toward the right ventricular apex. A pigtail catheter was advanced through the right femoral artery and placed in the left ventricle to perform a left ventriculogram in a 30-degree left anterior oblique projection to visualize the

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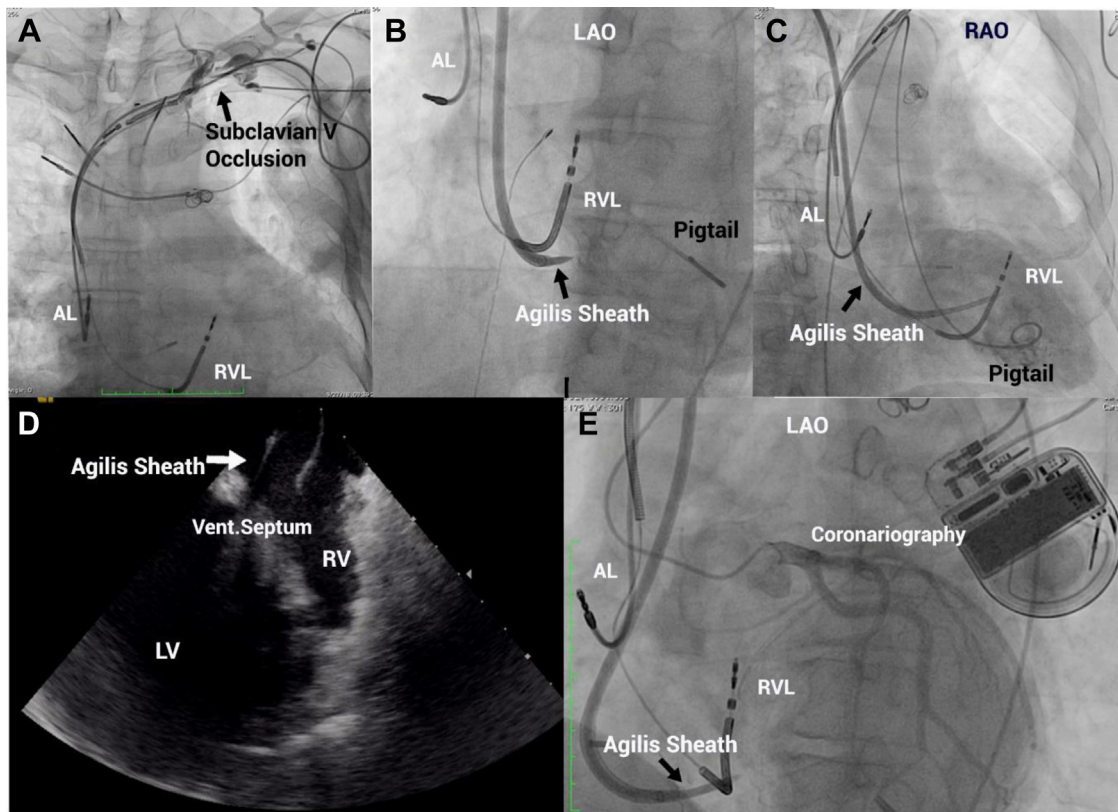


Figure 1 A: Anteroposterior fluoroscopic view showing left subclavian vein occlusion. B, C: Agilis sheath (St. Jude Medical, St. Paul, MN) placement at mid ventricular septum using left anterior oblique (LAO) and right anterior oblique (RAO) view. D: Confirmation of adequate sheath placement with intracardiac echocardiography. E: Coronariography showing no septal arteries close to ventricular septum puncture site. AL = atrial lead; LV = left ventricle; RV = right ventricle; RVL = right ventricular lead.

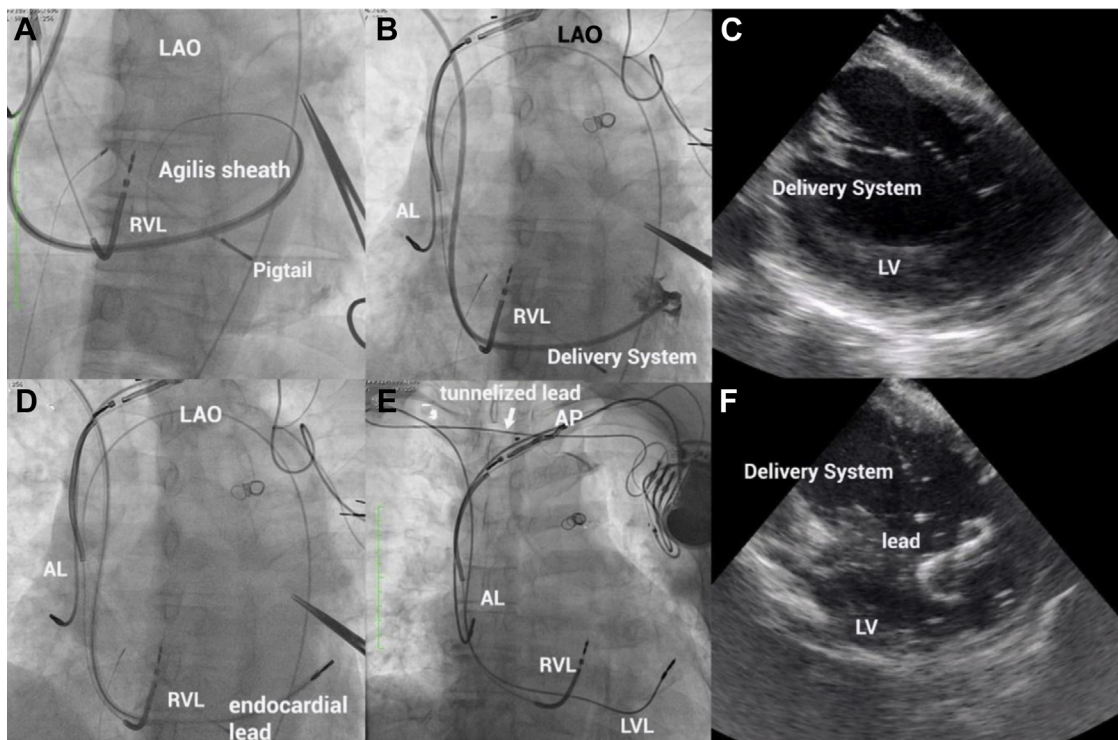


Figure 2 A: Successful ventricular transseptal puncture in left anterior oblique (LAO) view. B: Coronary sinus lead ventricular system is deployed over the guidewire and positioned at left ventricle (LV) lateral wall in LAO view. C: Confirmation of adequate positioning with intracardiac echocardiography. D: Implantation of endocardial lead at LV lateral wall with LAO view. E: Final LV lead position with anteroposterior (AP) view. F: Intracardiac echocardiography view showing adequate positioning of LV lead at LV lateral wall. AL = atrial lead; RVL = right ventricular lead.

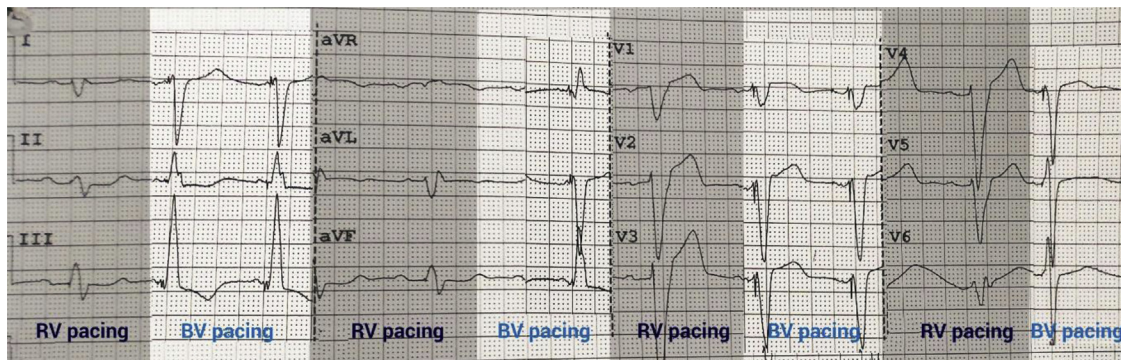


Figure 3 Electrocardiogram comparison of right ventricle (RV) pacing prior to the procedure and biventricular (BV) pacing after successful left ventricular lead implantation.

interventricular septum. Afterward we adjusted the steerable sheath's short curve, and slowly withdrew it while applying counterclockwise torque until the sheath's dilator engaged the mid portion of the interventricular septum. An ICE probe (AcuNav catheter, Siemens Healthcare, Erlangen, Germany) was used to observe the septum and ensure adequate position of the tip of the dilator. A coronary angiogram was performed in right anterior oblique view to ensure no septal arteries were in the vicinity of this site (Figure 1). The 0.032-inch guidewire was withdrawn, and we injected contrast through the sheath and dilator, to once again ensure adequate positioning. A high support guidewire (Amplatz Super Stiff, Boston Scientific, Marlborough, MA) was then advanced through the sheath's dilator until its stiff distal portion was against the mid portion of the interventricular septum. At the proximal, floppy portion of the guidewire, we delivered 30 W of cut electrocautery current, while applying gentle pressure. ICE and left ventriculography were used to confirm the passage of the guidewire in the left ventricle. Prior to this step, 100 U/kg of heparin was administered intravenously to ensure adequate anticoagulation.

The steerable sheath and dilator were then withdrawn and a CS lead delivery sheath (Selec Inside, Medtronic, Minneapolis, MN) was tracked over the wire into the left ventricle through the mid ventricular septum and positioned at the lateral basal portion of the left ventricle. After confirmation of adequate positioning with fluoroscopy, a 60-cm active fixation bipolar lead (Safio S, Biotronik, Berlin, Germany) was guided and successfully implanted into the endocardial wall. The sheath was withdrawn and after ascertaining adequate lead position and stability, and the distal portion of the lead was tunneled to the left subclavicular pocket, where it was secured and connected to a CRT-D generator (Lumax 740 HF-T Safio S, Biotronik) (Figure 2). Oral anticoagulation with warfarin was started after the procedure, and the patient was discharged once an international normalized ratio of 2.5 was reached. An electrocardiogram was recorded which showed a reduction of QRS duration of 40 ms (180 ms to 140 ms) (Figure 3).

Discussion

As was previously mentioned, CS stimulation is not always possible, as such other alternative pacing approaches have been developed and are increasingly being used. Currently, LV endocardial pacing seems to be superior to epicardial pacing. In 2013, the first case report of an interventricular septal approach was published.⁸ Recently, Gamble and colleagues⁹ published a case series of 20 patients, showing 100% success rate of the procedure and an 88% response rate. Although technically challenging, the implantation can be even harder without left subclavian patency. To our knowledge this is the first case of an interventricular septal endocardial lead implantation from a right subclavian vein approach. The difficulty in such a case derives from the curvature formed by the right subclavian vein and superior vena cava, which makes maneuvering the steerable sheath into the interventricular septum hard. The use of right and left ventriculograms, and ICE to guide the puncture, were incredibly useful and should be considered necessary for such a procedure.

Conclusion

A right subclavian approach for interventricular septal endocardial lead implantation is feasible in patients in whom left subclavian access is not possible.

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