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CASE REPORT
Heart failure

Cardiac resynchronization therapy from an iliac approach in a patient without superior access: a case report

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Background Cardiac resynchronization therapy (CRT) has been shown to benefit patients with heart failure and left bundle branch block (LBBB). However, CRT implantation is challenging when the superior venous access is not feasible.

Case summary A 50-year-old man with a history of dilated cardiomyopathy and complete LBBB was referred to our hospital for CRT management. Angiography showed that the left and right brachiocephalic veins were occluded. Cardiac resynchronization therapy was finally implanted via the iliac vein. Follow-up echocardiography showed improved cardiac function, and the pacing system was functioning properly.

Discussion The iliac vein access is feasible for CRT implantation with good stability, which can be a viable alternative to avoid unnecessary risk associated with thoracotomy and epicardial lead placement.

Keywords Cardiac resynchronization • Iliac vein • Biventricular pacemaker • Case report • Bilateral brachiocephalic vein occlusion

ESC curriculum 5.11 Cardiac resynchronization therapy devices • 6.2 Heart failure with reduced ejection fraction • 6.5 Cardiomyopathy

Learning points

- Cardiac resynchronization therapy can be implanted via the iliac vein approach when the superior venous access is not feasible.
- Compared with the femoral vein, the advantage of iliac access is that the leads are unaffected by lower limb activities.
- The adjustable 10-pole catheter used in ablation is recommended to transfer the long sheath into the coronary sinus from the iliac vein.

Introduction

Cardiac resynchronization therapy (CRT) has been demonstrated to improve symptoms, cardiac function and mortality of patients with heart failure and complete left bundle branch block (LBBB).[1] The standard superior implantation approach has a high success rate with acceptable risk profile.[2] When the superior approach is not feasible, the iliac approach may be considered instead of surgical implantation of an epicardial left ventricular (LV) lead. We recently treated a patient whose bilateral subclavian vein access was occluded by successfully implanting CRT via the iliac approach.

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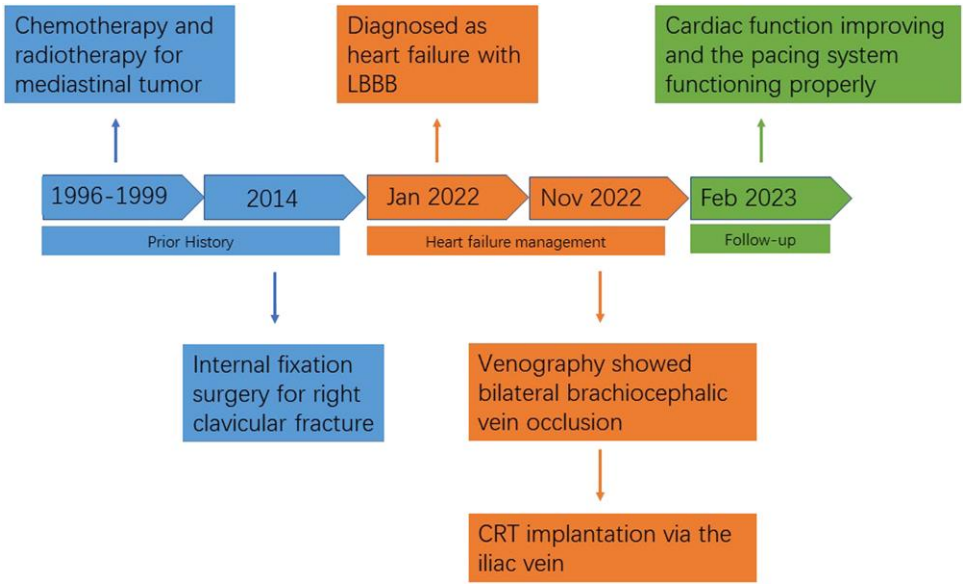
Summary figure



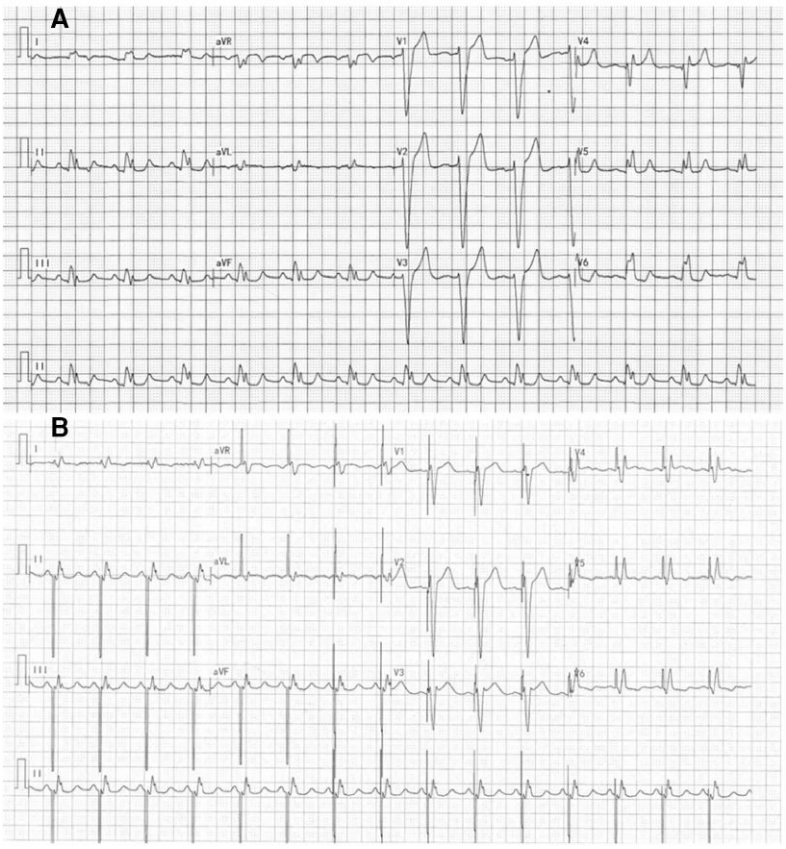


Figure 1 The pre- and post-operative electrocardiograms. (*A*) The pre-operative electrocardiogram showed complete left bundle branch block with QRS duration was 165 ms. (*B*) The post-operative electrocardiogram showed narrower QRS duration of 120 ms.

Case summary

A 50-year-old Chinese male patient with dilated cardiomyopathy, LV ejection fraction 31–34%, and complete LBBB was admitted to other hospitals for recurrent shortness of breath. In January 2022, he was admitted to our hospital because of chest tightness and shortness of breath. The electrocardiogram (ECG) showed complete LBBB (*Figure 1A*). The echocardiogram revealed LV enlargement with decreased systolic function, LV ejection fraction of 31%, with normal coronary computed tomography angiography. After optimized medical therapy including sacubitril valsartan, bisoprolol, spironolactone, and dapagliflozin, his symptoms of heart failure showed minor improvement (NYHA Classes III and IV), and the follow-up echocardiogram in November 2022 suggested an LV ejection fraction of 34%, with LV end diastolic/systolic diameter 60/48 mm and moderate mitral regurgitation.

The patient had a history of mediastinal tumour in 1996 and underwent chemotherapy and radiotherapy from 1996 to 1999. Since then, multiple varicose veins had appeared on his chest wall (*Figure 2*). He was treated with internal fixation for right clavicular fracture in 2014. He had no history of hypertension or diabetes.

His physical examination findings were as follows. His height was 172 cm, and his weight was 68 kg. Inspection of the chest wall revealed multiple varicose veins. The percussion showed an enlarged cardiac boundary. No peripheral oedema. The auscultation of the chest revealed some fine moist rales.

The laboratory tests showed normal liver and kidney function and no anaemia, and the NT-proBNP level was 2450 pg/mL.

The clinical history, presentation, and timing of his symptoms suggested that his heart failure were attributable to dilated cardiomyopathy. Hence, CRT with defibrillator (CRT-D) was recommended for the patient.

The patient was placed under local anaesthesia of subclavian incision for implantation of CRT-D. After puncturing the left and right subclavian veins successively, the guide wire could not reach the superior vena cava. Angiography showed that the left and right brachiocephalic veins were occluded (*Figure 3A* and *B*). We successively tried ultra-slippery guide wire, Sion blue guide wire and Pilot 50 guide wire, but all of them failed to pass through the occluded veins. After discussing the operational risk and treatment alternatives with the patient, we had to change the plan and proposed implantation of a CRT system via the right iliac approach, which was accepted by the patient. Considerations of the size and weight of the pacemaker and the low possibility of obtaining an effective defibrillation vector at the level of the right lower abdominal region led to the selection of a CRT without defibrillator.

After puncturing the right iliac vein, we successfully inserted three guide wires. The coronary sinus (CS) sheath (CPS 410211) was introduced over the deflectable 10-pole electrophysiology catheter (Boston Science) and advanced to the CS. The coronary retrograde venography was performed (*Figure 4A*), and a posterior vein was selected as the target vein for placement of the LV lead (St. Jude 1458Q-85 cm) (*Figure 4B*). The pacing parameters were satisfactory, and there was no diaphragm stimulation with high-voltage output. Then the right ventricular electrode lead (St. Jude 2088TC-58 cm) and the right atrial electrode lead (St. Jude 2088TC-58 cm) were implanted via the right iliac vein using peel-away introducers and positioned in the right ventricular apex and right atrial appendage (*Figure 4B*). Acute thresholds were 1.0 V/0.4 ms for the right ventricular lead and 1.0 V/0.4 ms for the right atrial lead, with impedances of 520 Ω and 560 Ω, sensing of 6.0 and 2.5 mV, respectively. The generator (St. Jude PM3242) was implanted in the lower-right abdominal pocket (*Figure 4C*). The post-operative ECG showed QRS duration of 120 ms (*Figure 1B*), which was much narrower than pre-operative QRS duration.

Figure 2 The varicose veins on his chest wall after radiotherapy.

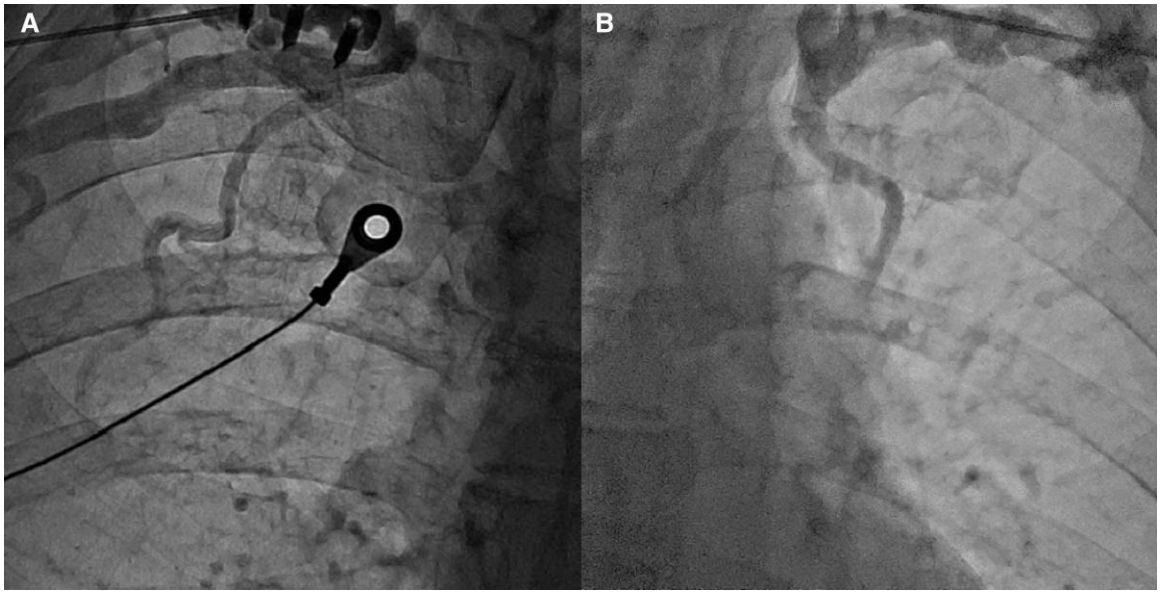


Figure 3 Angiography of the right and left subclavian vein. (*A*) The right brachiocephalic vein was occluded with the varicose vein of right chest wall. (*B*) The left brachiocephalic vein was occluded with the varicose vein of left chest wall.

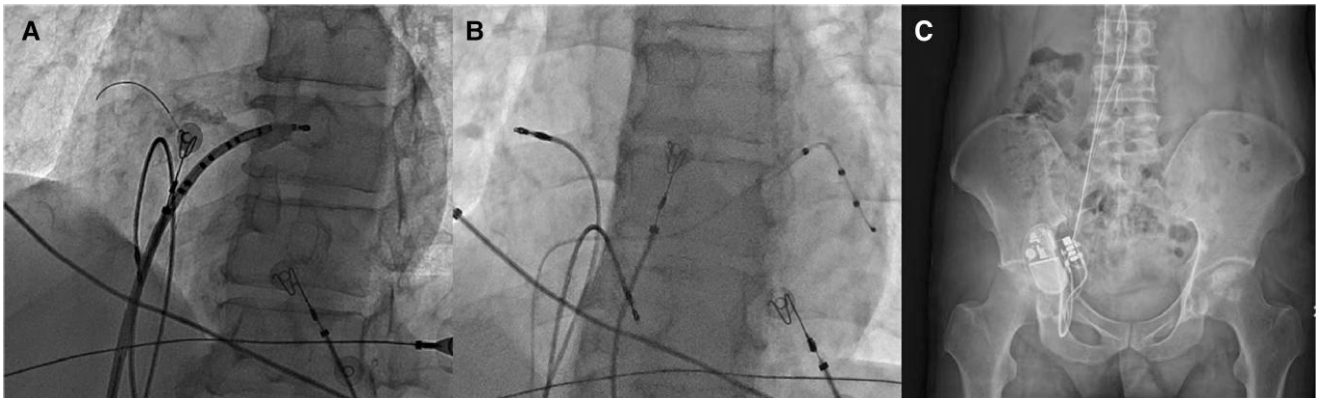


Figure 4 The implantation of cardiac resynchronization therapy by the right iliac vein. (*A*) The coronary retrograde venography. (*B*) The positions of three leads of cardiac resynchronization therapy system. (*C*) The generator placement in the pocket of low-right abdominal wall.

The first follow-up visit was 3 months after CRT implantation. The patient's condition had improved markedly to NYHA Class I. No lower limb symptoms occurred and no oedema. He could travel around the country. The pacing system was functioning properly (*Figure 5*). The NT-proBNP level has decreased to 520 pg/mL, and the echocardiogram showed that LV ejection fraction increased to 40%, with LV end diastolic/systolic diameter 51/36 mm and mild mitral regurgitation.

Discussion

Cardiac resynchronization therapy is a well-established treatment for heart failure. Conventional pacing via the femoral access is common.[3–5] However, CRT implantation through the iliac vein is rarely reported. The present case showed that the iliac access is feasible for CRT with good stability as confirmed by the follow-up.

There are few case reports of CRT implantation through the femoral or iliac vein.[5–11] Indications for implanting pacemaker through the femoral or iliac vein include occluded subclavian veins or superior vena cava, multiple leads in the superior vena cava, the narrow gap between bilateral clavicles and the first rib, lead infection, mastectomy and/or thoracic radiotherapy, the thin chest wall skin unsuitable for device burial, recurrent bilateral subclavian pocket erosion, etc.[6–11] In our patient, bilateral brachiocephalic venous obstruction was probably caused by local vascular fibrosis due to previous radiotherapy. There were few similar cases but no exact incidence of complete upper venous obstruction in patients with previous mediastinal radiotherapy.[12]

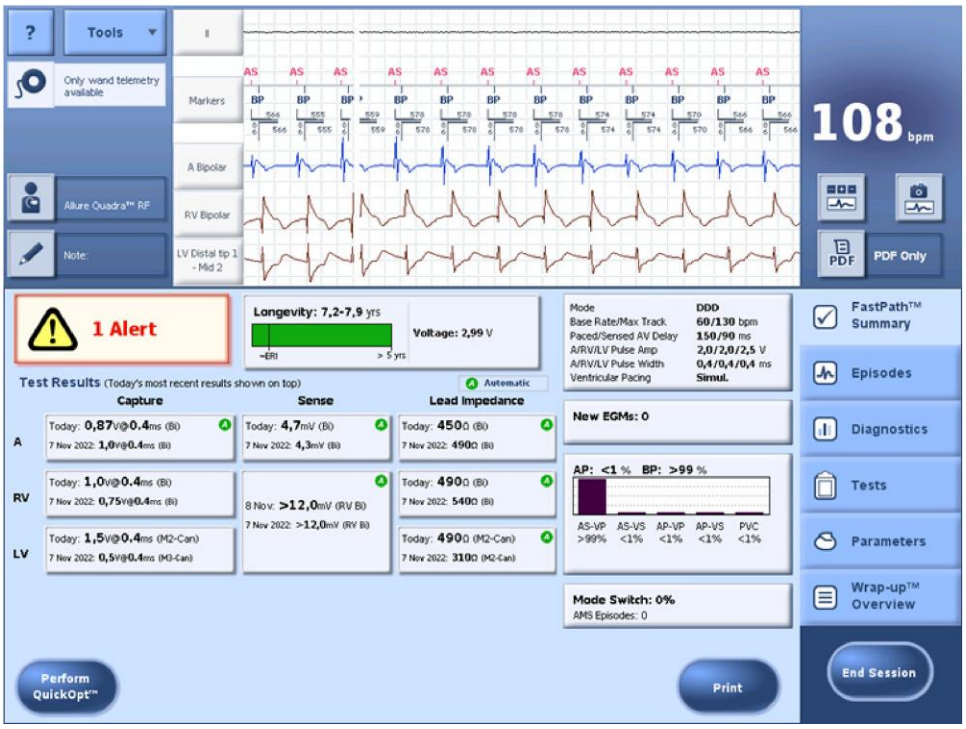


Figure 5 The parameters were stable after post-operative 3 months.

Higgins *et al.*[1] reported a CRT-D implantation case through the iliac vein route. They selected dual coil defibrillation lead to ensure a safe defibrillation threshold, which is unavailable at our hospital. Although we did not place the single-coil shocking electrode due to the low possibility of an effective defibrillation vector at the level of the lower right abdominal region, we discussed with the patient about the possibility of combining CRT with S-ICD in the future. Since LV lead was placed in the posterior vein and the post-operative ECG showed narrow QRS duration, the best outcome would be if the patient's cardiac function can be improved by guideline-directed medical therapy (GDMT) and CRT so that ICD is not required. In addition, the DANISH study and the RESET-CRT project indicated that CRT-P treatment was not associated with inferior survival compared with CRT-D.[13,14] The follow-up result showed that our strategy is practical.

Compared with the femoral vein, the advantage of iliac access is that the leads are unaffected by lower limb activities, indicating no impact on patients' daily life and reducing the occurrence of lead dislocation. The key point of the external iliac vein puncture is at the 1–1.5 cm point inside the femoral artery pulsation above the inguinal fold, and ultrasound guidance is unavailable at our centre. In order to avoid dislocation of the leads due to insufficient length, the ventricular active fixation leads were selected as both atrial and ventricular leads. The position of the generator pocket was also adjusted appropriately for the leads. The length of the right ventricular leads used in previous cases were 80–85 cm,[8–11] which was also unavailable at our centre. The length of the ventricular active fixation lead at our hospital is 58–60 cm. The pre-operative evaluation suggested that 58 cm was sufficient for our patient whose height was 172 cm. In addition, it may be more convenient to use the adjustable 10-pole catheter used in ablation to transfer the long sheath into the CS from the external iliac vein. The traditional LV delivery system is long enough to support the implantation of LV lead into the target vein.

Conclusion

The present case confirms the feasibility of biventricular pacing through iliac vein access when the superior venous route is inaccessible or contraindicated. Most importantly, this approach may be a viable alternative to avoid unnecessary risk associated with thoracotomy and epicardial lead placement.

Lead author biography

Dr. Xu. is from Shanghai Zhongshan Hospital, Fudan University. She has been a cardiologist for over 10 years, hoping to exchange the clinical experience with colleagues all over the world.

Consent: Written informed consent was received from the patient for publishing this article in accordance with COPE guidelines.

Conflicts of interest : None declared.

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Data availability: The data underlying this article will be shared on reasonable request to the corresponding author.

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