INNOVATIVE TECHNIQUES

COMPLEX CASE STUDY

Cardiac Resynchronization Therapy with the Left Ventricular Lead Placed Through a Tunnel Across the Anterior Chest

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ABSTRACT. Cardiac resynchronization therapy may improve ventricular contraction in patients with cardiomyopathy and prolonged QRS complex. However, failure to place the left ventricular (LV) lead may occur. A 64-year-old man had severe dilated non-ischemic cardiomyopathy and heart failure (New York Heart Association Functional Class III). The electrocardiogram showed normal sinus rhythm, left bundle branch block, and prolonged QRS complex (189 ms). A biventricular implantable cardiac defibrillator generator was placed at the right pectoral region because he was left-hand dominant. The right atrial and right ventricular leads were implanted successfully, but the LV lead could not be placed. Subsequently, the distal end of the LV lead was inserted into the left subclavian vein, advanced to the right heart, and positioned at the posterolateral branch of the coronary sinus; the proximal end of the lead was tunneled across the anterior chest and connected to the generator at the contralateral, right pectoral region. Proper lead position was confirmed with chest radiography and electrocardiography. In summary, the LV lead for cardiac resynchronization therapy may be placed from the left subclavian vein and connected to the generator at the right pectoral region through an anterior chest tunnel.

KEYWORDS. electrocardiogram, heart failure, QRS complex, technique.

Introduction

Cardiac resynchronization therapy is a useful option for patients with advanced congestive heart failure (New York Heart Association (NYHA) Functional Class III and IV), decreased left ventricular ejection fraction (<35%), and electrical dyssynchrony (prolonged QRS complex >120 ms). This therapy may restore the ventricular contraction pattern with synchronized biventricular pacing from right ventricular and left ventricular (LV) leads. However, implantation of leads can be challenging, and the implanted LV lead may not reach the targeted coronary sinus branch in 10% of patients. Major causes of failure include failure to insert the lead into a proper branch of the coronary sinus (2–14%), failure to cannulate the coronary sinus (6%), inability to obtain a stable pacing site (5%), inability to obtain adequate pacing threshold (1%), coronary sinus dissection or perforation (1%), diaphragmatic stimulation that may not be corrected (0.2%), and vascular trauma when attempting venous access (0.2%). In addition to mechanical lead failure, dislodgement of LV leads immediately after implant can occur in 6–8% of patients.

We treated a patient who had an unsuccessful attempt at placement of an LV lead and who declined surgery for lead placement. Successful transvenous lead placement was achieved with a previously described method using a percutaneous tunnel across the anterior chest.

Case report

A 64-year-old man presented for treatment of severe dilated non-ischemic cardiomyopathy and heart failure...
NYHA Functional Class III). The electrocardiogram showed normal sinus rhythm, left bundle branch block, and prolonged QRS complex (189 ms) (Figure 1). Cardiac magnetic resonance imaging was consistent with idiopathic cardiomyopathy. Evaluation with two-dimensional echocardiography showed decreased LV ejection fraction (17%), severe central mitral regurgitation, increased LV end-diastolic dimension (8.9 cm), and increased LV endsystolic dimension (7.6 cm).

The patient had inadequate response to maximal pharmacotherapy, and a biventricular implantable cardiac defibrillator was recommended. The generator was placed in the right pectoral area because the patient was left-hand dominant. The right atrial and right ventricular leads were implanted successfully. However, the LV lead could not be placed from the right side because of technical difficulty associated with the dilated heart chambers and displaced coronary sinus ostium (CSO); the selective cannulation of the CSO could not be achieved by all the available right-sided cannulating systems and the procedure was stopped. Surgery to implant the LV lead was offered but declined by the patient.

Percutaneous implantation of the LV lead was performed under general anesthesia. An incision was made for access to the left subclavian vein. A small subcutaneous pocket was created to accommodate and anchor the percutaneous LV lead. The coronary sinus was selectively cannulated by a 9-French sahesheath Worley jumbo 50 µm braided core series. The distal end of the LV lead was positioned at the posterolateral branch of the coronary sinus. A subcutaneous tunnel was created with blunt dissection across the anterior chest, between the generator site at the right pectoral region and the area at the left pectoral region where the LV lead was anchored. The proximal end of the LV lead was passed through the tunnel: a hemostat was passed through the tunnel and used to pull a premeasured mid-length of a 14-French Foley catheter from left to right through the tunnel to maintain tunnel patency; a suture was tied to the LV lead and passed through the Foley catheter from left to right; and the Foley catheter was removed. The proximal end of the LV lead was connected to the generator at the right pectoral region. The LV lead was tested and anchored to the left pectoral muscle, and the small pocket was closed. Proper positioning of all leads was confirmed with chest radiography and electrocardiography (Figures 2 and 3).

The patient was discharged home the next day. Follow-up evaluation showed decreased β-natriuretic peptide level (before defibrillator placement, 1,890 pg/ml; 6 months after defibrillator placement, 107 pg/ml) and improved functional level (10 months after defibrillator placement, NYHA Functional Class II).

**Discussion**

The present case illustrated a technique for LV lead placement that had been described previously in patients who had LV lead insertion failure because of venous occlusion or stenosis. We used a longer subcutaneous tunnel across the anterior chest and a Foley catheter to facilitate passing the lead through the tunnel. Lead
placement was accomplished with routinely available instruments and avoided lead kinking or twisting. The same technique likely can be used in patients with other anatomic deterrents to LV lead placement such as a persistent left superior vena cava.

An approach to the right pectoral region was preferred because the patient was left-hand dominant. Although most cardiac resynchronization therapy cases are done with left pectoral localization, right pectoral entry and pacemaker placement may be performed in 10% of cases.13,14 The right-sided approach typically may not have major anatomic or surgical challenges.14 Proper implantation usually is achieved by catheterizing the lateral vein or posterolateral venous branches of the coronary sinus.15,16

Figure 2: Chest radiographs confirming proper positioning of all leads after placement of the implantable cardiac defibrillator for cardiac resynchronization therapy. (A) Posteroanterior view showing the right atrial lead (arrowhead) and right ventricular lead (arrow) at the mid septum. The tip of the LV lead is noted at the posterolateral branch of the coronary sinus (arrow). (B) Lateral view shows the distal end of the LV lead at the posterolateral branch of the coronary sinus (arrowheads).

Figure 3: Electrocardiogram showing biventricular paced rhythm after placement of the implantable cardiac defibrillator for cardiac resynchronization therapy. Proper position of the posterolateral LV lead is confirmed by the presence of the Q wave in leads I, aVL, and V6; superior axis; and R wave in leads V1 and V2.
Routine cardiac resynchronization therapy includes confinement of the generator and corresponding hardware to one side of the chest. When both sides of the chest are used, there may be an increased risk of venous occlusion without future potential for revision at an unused pectoral site. Nevertheless, the present case showed that contralateral transvenous LV lead placement may be acceptable in select patients. The technique may be a useful option for the interventional electrophysiologist, especially after initial failure to achieve LV lead placement for cardiac resynchronization therapy in a patient who declines or has contraindications to surgery.

References