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Case Report

The usefulness of balloon occlusive left ventricular lead delivery in combination with the quadripolar active fixation lead for a patient with complex coronary venous morphology

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A B S T R A C T

Complex coronary vein morphology impedes the insertion of the left ventricular (LV) lead and reduces the effectiveness of cardiac resynchronization therapy (CRT). A 77-year-old woman underwent dual-chamber pacemaker implantation via the left subclavian approach for a complete atrioventricular block 17 years previously. She was hospitalized due to decompensated heart failure, and her cardiac rhythm completely depended on ventricular pacing at that time. Transthoracic echocardiography showed thinning of the ventricular septum in the basal region and pacing-induced dyssynchrony. She was clinically diagnosed with cardiac sarcoidosis with severe LV systolic dysfunction. She was referred for an upgrade to CRT. Given that prior contrast venography showed occlusion of the left subclavian vein, an additional LV lead was inserted through the right subclavian vein. Coronary venography showed a lateral vein that branched from the great cardiac vein with an acute angle and had multiple tortuosities in the peripheral branches. Since the LV lead placement was unsuccessful with the conventional method, we attempted the lead placement using the balloon occlusion technique (BOT). Lead delivery into the anatomical optimal lateral vein was successful by using BOT, and LV pacing from the most delayed basal region was achieved in combination with the active fixation LV lead.

<**Learning objective:** The balloon occlusion technique in cardiac resynchronization therapy implantation has been introduced to achieve left ventricular (LV) lead insertion into the coronary vein with a complex morphology. A quadripolar active fixation LV lead, which has been recently developed, has a low dislodgement rate and enables lead placement to the desired location. Application of conventional techniques in combination with the active fixation LV lead is expected to improve the success rate of optimal LV pacing in patients with complex coronary vein morphology.>

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Introduction

Substantial technological progress, such as coronary sinus (CS) cannulation tools and left ventricular (LV) pacing leads, and the accumulation of experience of operating physicians has contributed to improve the success rate of cardiac resynchronization therapy (CRT) and reduce procedural complications. The most important factor that determines the success of CRT is to place the LV lead at the optimal pacing site. Here, we report the usefulness of the balloon occlusion technique (BOT) [1,2] in combination with the active fixation LV lead in a patient in whom delivering the LV lead is challenging due to the complex morphology of the coronary vein.

Case report

A 77-year-old woman who developed complete atrioventricular block underwent dual-chamber pacemaker implantation from the left subclavian vein 17 years previously. She was first hospitalized six months before this one due to decompensated heart failure (HF). During that period, her underlying heart rhythm completely depended on the right ventricular pacing, and the QRS complex of the electrocardiogram was extended to 210 msec. Transthoracic

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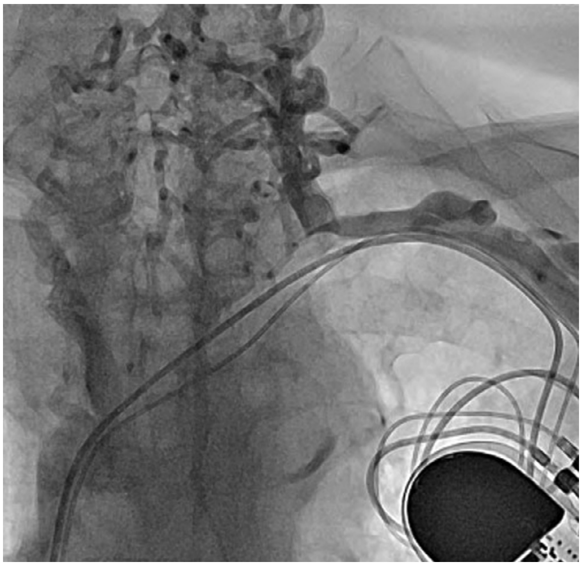

Fig. 1. Prior contrast venography of the left subclavian vein. The contrast venography shows occlusion of the left subclavian vein and the development of collateral veins.

echocardiography revealed dilatation of the left ventricle, thinning of the interventricular septum in the basal region, and severe LV systolic dysfunction (LV ejection fraction 25%) with pacing-induced dyssynchrony. As a result of a detailed examination, she was diagnosed clinically with cardiac sarcoidosis. She was referred to our hospital for an upgrade to CRT after undergoing guideline-directed medical therapy for HF. Although this patient had been implanted with a pacemaker for several years, notable lethal ventricular tachyarrhythmias were not detected in the pacemaker record. Furthermore, the patient and her family did not wish to have a CRT-defibrillator implantation due to her low activity. Therefore, we determined that CRT-pacemaker implantation was suitable for this patient.

Due to prior contrast venography showing occlusion of the left subclavian vein and the development of collateral veins (Fig. 1), an additional LV lead was inserted through the right subclavian vein. First, CS angiography was performed via the right subclavian vein using a pre-shaped long sheath (6250VIC MPR/Attain Command, Medtronic, Minneapolis, MN, USA) to search for suitable lateral or posterolateral branches. A lateral vein branching from the great cardiac vein (GCV) at an acute angle and having multiple tortuosities in the peripheral branches was identified as an anatomical optimal coronary vein (Fig. 2A, B). To achieve LV pacing at the base or mid-portion of the left ventricle, we chose a quadripolar active fixation LV lead (4798/Attain Stability Quad, Medtronic) and introduced the LV lead via the guiding sheath to the target vein using the standard over-the-wire technique. However, this procedure failed due to the absence of the required support to deliver the LV lead into the target vein. The guidewire and LV lead dropped into the GCV, and several attempts failed despite the use of an angulated tip inner catheter (6248VI-130/Attain Select II, Medtronic). Therefore, we decided to perform the BOT as the next alternative.

We cannulated the additional sheath (6250VIC MPR/Attain Command, Medtronic) into the CS ostium and placed a balloon catheter (6215/Attain Venogram Balloon Catheter, Medtronic) to occlude the cardiac vein slightly distal to the branch point of the target vein (Fig. 3A). While expanding the balloon, a quadripolar active fixation LV lead with a force propelling the system over the wires was directed toward the target vein (Fig. 3B). The LV lead was advanced into the target vein and the tip was placed on the mid-portion of the LV lateral wall. As shown in Fig. 3C, the time interval from right ventricular pacing to LV sensing was extended on the base-side of the left ventricle. No local conduction delay after LV pacing was observed at any of the pacing electrodes. After the side helix of the LV lead was abutted along with the target venous wall, the helix was fixed into the venous wall by clockwise rotation of the lead body (Fig. 3C). The LV pacing threshold at each electrode was acceptable (<1.25 V at 0.4 msec) without diaphragmatic stimulation. The LV pacing lead was led from the right side through a subcutaneous tunnel to the left device pocket and connected to the pulse generator. The QRS complex after biventricular pacing was reduced to 142 msec. After removing the guiding sheath and guidewire, no change was observed in the position of the LV lead (Fig. 3D). Six months after the CRT upgrade procedure, the pacing status was stable and she had not been hospitalized for worsening HF.

Discussion

In recent years, a quadripolar LV lead has become the mainstream of CRT because more pacing vectors can be selected and it is easier to avoid phrenic nerve stimulation. A conventional quadripolar passive fixation LV lead usually requires the lead tip to be wedged in the target branch to avoid lead dislodgment. Even if such an implantation procedure was performed, a significant number of patients will still experience LV lead dislodgement [3,4]. On the other hand, a novel quadripolar active fixation LV lead was expected to reduce lead dislodgement, regardless of the coronary venous morphology. The initial United Kingdom experience reported a high success rate of the novel quadripolar active fixation LV lead placement (98.8%) and no dislodgement [5]. The Attain Stability Quad Clinical Study results also reported a high success rate of LV lead placement (96.8%) with a low dislodgement rate (0.7%). Furthermore, the success rate of placement in the prespecified target pacing location was 97%, and in 90.6% of them, a tip electrode was located in the non-apical region [6]. In the present case, the peripheral venous diameter of the lateral vein was sufficient for lead placement; however, pacing from the apical region was unavoidable when a conventional LV lead was used. Thus, the use of active fixation LV lead may be beneficial in achieving LV pacing at the optimal pacing site.

Compared with de novo CRT implants, CRT upgrade procedures were associated with higher rates of in-hospital mortality and procedural-related complications such as cardiac perforation and lead dislodgement [7]. As observed in the present case, severe venous obstruction or occlusion occurs in 10%–25% of patients with prior leads, and the benefits of CRT upgrade should be weighed with the procedural risk and complexity of placing an additional lead [8]. It was very difficult to place an LV lead in our case because the selected lateral branch took off with an acute angle and curves, in addition to multiple tortuosities. Moreover, enough backup is often not delivered to the guidewire or LV lead, especially when approaching via the right subclavian vein.

The BOT in CRT has been used for over 10 years. Fortunately, the LV lead was successfully placed by using this technique in the present case. However, if it had failed, the snare technique from the orthodromic or retrograde approach, anchor balloon technique, and coronary vein venoplasty would have been considered as alternative methods. The snare technique from the orthodromic or retrograde approach has also been described for over 10 years. Ahmed et al. reported an innovative retrograde approach without using snare [9]. Worley et al. reported that the snare does not evoke credentialing concerns and can be easily implanted by most implant-

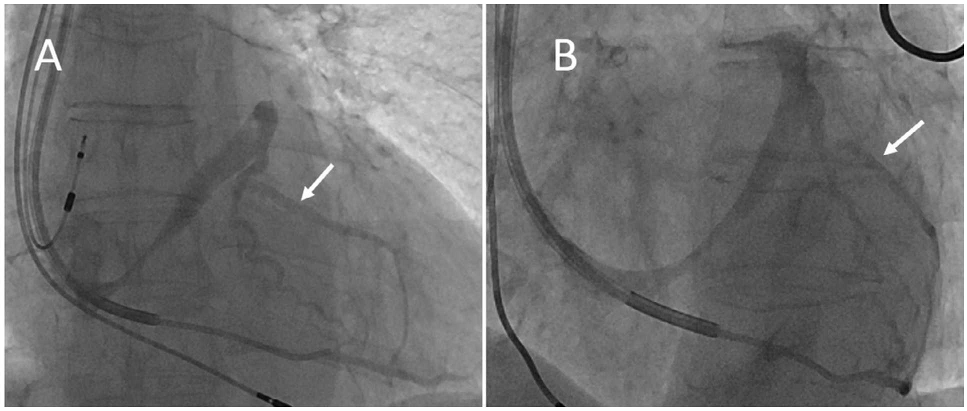

Fig. 2. Coronary sinus venography after the selective injection of contrast in the middle cardiac vein. (A) Anterior-posterior projection. (B) Left posterior oblique projection. The target vessel is marked by arrows.

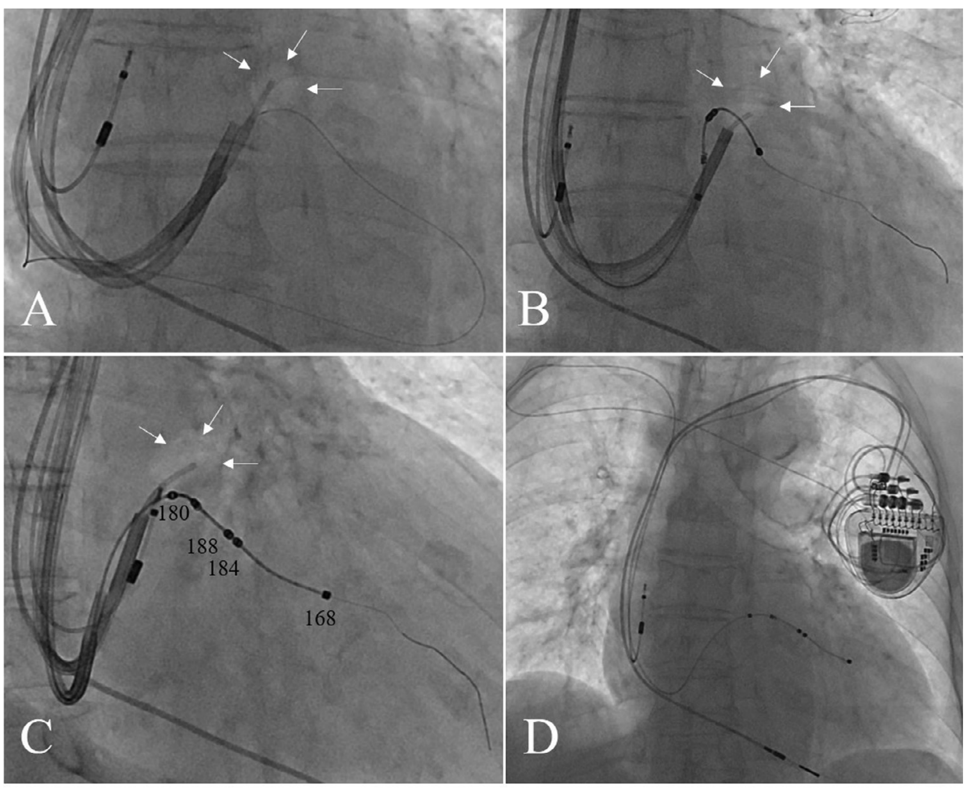

Fig. 3. (A) Distal occlusion of the coronary sinus by the balloon catheter. The inflated balloon is marked by white arrows.
(B) Lead insertion into the target vein using the balloon occlusion technique. The inflated balloon is marked by white arrows.
(C) Fixation of the left ventricular (LV) lead (Medtronic 4798 active fixation quadripolar single-canted lead) to the target vein at the basal portion of the left ventricle (in right posterior oblique projection). The numbers displayed near the electrodes indicate the time interval (msec) from right ventricular pacing to LV sensing at each electrode of the LV lead. The inflated balloon is marked by white arrows.
(D) Chest X-ray after implantation (in anterior-posterior projection).

ing physicians [10]. The anchor balloon technique was introduced as the inflation of a balloon at a distal lesion in challenging cases of coronary intervention. This technique is also useful for deep engagement of the guiding catheter in the target vein. Coronary vein venoplasty during CRT is not common in Japan. However, in cases with occlusion or stenosis of the target vein, coronary vein venoplasty may be a promising alternative strategy.

In conclusion, the BOT in combination with the quadripolar active fixation LV lead was useful for a patient with a complex coronary venous morphology such as acute angulated take-off and multiple tortuosities.

Conflict of interest

Dr Shingo Sasaki has received research grant supports from Medtronic Japan Co., Ltd. and Fukuda Denshi Kita-tohoku Hanbai Co., Ltd. and BIOTRONIK Japan Co., Ltd. Dr Shingo Sasaki has received scholarship donation from Japan Lifeline Co., Ltd and Boston

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