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Left Bundle Branch-Optimized Cardiac Resynchronization Therapy Using Stylet-Driven Pacing Leads with a Steerable Delivery Sheath in Patients with Atrial Fibrillation Accompanied by Slow Ventricular Response

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A 76-year-old man presented to the emergency department with exertional dyspnea and weakness. He had a history of percutaneous coronary intervention for ST elevation of myocardial infarction two years ago and was hospitalized twice last year for atrial fibrillation and worsening heart failure one year ago. He was prescribed apixaban 10 mg, clopidogrel 75 mg, dapagliflozin 10 mg, furosemide 40 mg, spironolactone 25 mg, and sacubitril/valsartan 200 mg. Twelve-lead electrocardiography (ECG) showed atrial fibrillation (AF) with slow ventricular response (SVR) (Fig. 1A). Chest radiography showed cardiomegaly with both pleural effusion (Fig. 1B). Two-dimensional echocardiography showed global hypokinesia (ejection fraction 38%) and an enlarged atrium. Given the impaired LV function and the deleterious effects of right ventricular pacing (RVP), left bundle branch-optimized cardiac resynchronization therapy (LOT-CRT) was attempted.

A 12-lead ECG and intracardiac electrogram were continuously recorded using an electrophysiology system (Prucka CardioLab, GE Healthcare, Waukesha, WI). A Tendril STS Model 2088TC lead (Abbott, St. Paul, MN, USA) was placed through the electrode-incorporated steer-

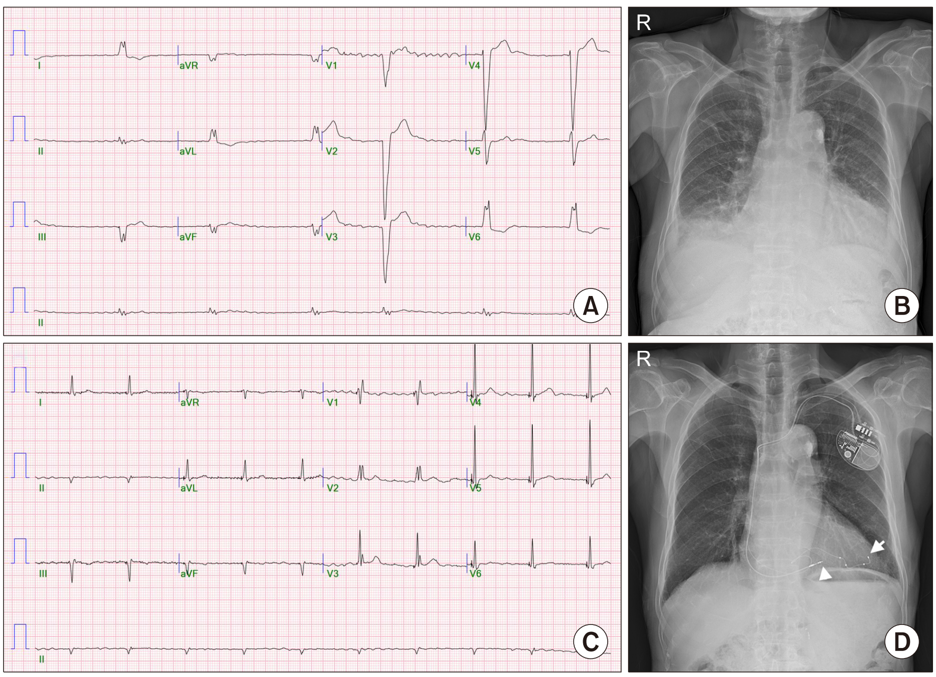

Fig. 1. (A) Twelve-lead electrocardiography (ECG) shows left bundle branch block and irregular RR interval with 38 beats per minutes. (B) Chest radiography shows cardiomegaly with both pleural effusion. (C) Twelve-lead ECG shows rSR' in lead V1, rS in inferior leads, qR in lead I and aVL with superior QRS axis. (D) Chest radiography shows improved cardiomegaly, and the ventricular lead was positioned at the left bundle branch (triangle) and posterolateral branch (arrow).

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Article History:
Received January 21, 2024
Revised February 11, 2024
Accepted February 15, 2024

https://doi.org/10.4068/cmj.2024.60.2.131

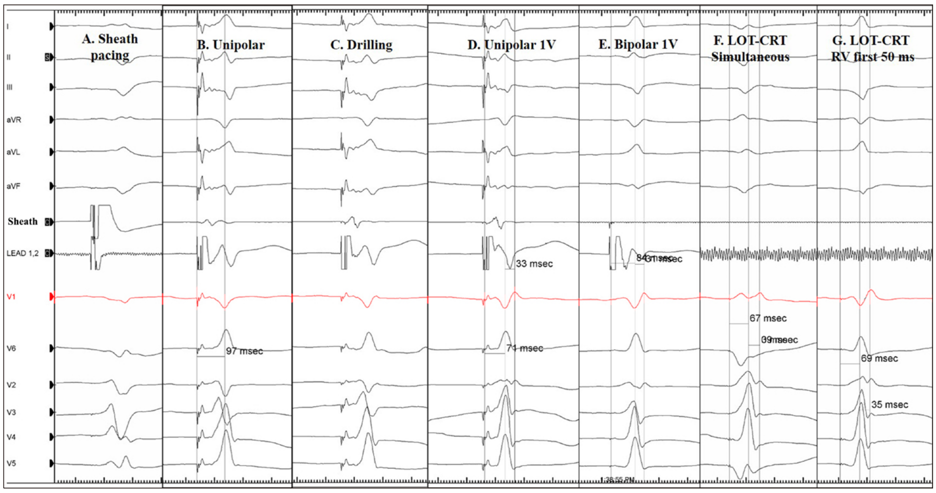

Fig. 2. (A) Sheath pacing showed a W pattern with a notch at the nadir of the QRS in the V1. (B-E) Clockwise rotation revealed a 'r' pattern in V1, peak left ventricular activation time (LVAT) of 75 ms in V6, V6–V1 interval of 33 ms, and QRS duration of 118 ms. (F, G) After left ventricular lead was positioned at the posterolateral branch, electrocardiogram showed a typical 'r' pattern in V1, peak LVAT of 69 ms in V6, V6–V1 interval of 35 ms, and a QRS duration of 110 ms.

able catheter (Abbott Agilis HisPro™) with monitoring of paced QRS morphology and unipolar impedance. Initial mapping of His-bundle potential, attempted under fluoroscopic RAO 30, was not prominent. Using the tricuspid annulus ring as a marker, the sheath was repositioned towards the right ventricular apex and rotated counterclockwise to contact the interventricular septum perpendicularly. Sheath pacing showed a W pattern with a notch at the nadir of the QRS in the V1 (Fig. 2). Clockwise rotation revealed an 'r' pattern in V1, a peak left ventricular activation time (LVAT) of 75 ms in V6, V6–V1 interval of 33 ms, and QRS duration of 118 ms. After left bundle branch implantation, a left ventricular lead (Quartet™ model 1458Q, Abbott, Sylmar CA) was positioned at the posterolateral branch. A final electrogram showed a typical 'r' pattern in V1, peak LVAT of 69 ms in V6, V6-V1 interval of 35 ms, and a QRS duration of 110 ms. After biventricular pacemaker (Quadra Allure MP™, Abbott, Sylmar CA) was implanted, the 12-lead ECG showed rSR' in lead V1, rS in inferior leads, qR in lead I, and aVL with superior QRS axis (Fig. 1C). At the 2-year follow-up, the patient was free of any symptoms. A chest X-ray revealed improved cardiomegaly, and the ventricular lead was positioned at the left bundle branch and posterolateral branch (Fig. 1D). Follow-up echocardiography showed improved LV function (EF 53%).

Chronic RVP can cause or worsen heart failure and increase cardiac mortality. Prolonged RVP may lead to pacing-induced cardiomyopathy, occurring in 10.1% of patients during a 3-year follow-up.[1] According to current guidelines, biventricular (BiV)-CRT is recommended in patients with an EF of 36-50% who develop AV block and are expected to require >40% RV pacing.[2] In the BLOCK-HF study, focused on patients with EF <50%, BiV-CRT outperformed RV pacing in reducing composite endpoints, primarily driven by heart failure hospitalization, without discernible differences in cardiac mortality.[3] However, it remains unclear as to whether BiV-CRT would be as effective in patients with AF due to limited data. In patients with AF, there is no atrioventricular synchrony, leading to the association of pacemaker-induced cardiomyopathy (PICM). Moreover, AF diminishes the response to BiV-CRT, resulting in higher long-term mortality post-implantation compared to sinus rhythm.[4]

Recently, conduction system pacing, which includes his bundle pacing (HBP) or left bundle branch area pacing (LBBAP), holds great promise as it may avoid the risk of PICM while allowing for the implantation of a dual chamber pacing system. HBP and LBBAP are rapidly evolving with regard to their implantation techniques, optimization of lead location, acute assessment of physiologic response, long-term pacing thresholds, lead longevity, and patient outcomes. Combining the conventional CRT with LBBAP is intriguing or even mechanistically desirable based on the ultimate goal to achieve pacing-mediated contractile synchrony.[5] Attempting LOT-CRT, combining left bundle branch pacing with biventricular pacing to achieve ventricular-ventricular (VV) synchrony, may offer a more effective treatment, especially in AF patients with HF.

ACKNOWLEDGEMENTS

This study was supported by research funds from Chosun University, 2019.

CONFLICT OF INTEREST STATEMENT

None declared.

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