Y-Adaptor Connection for LV Lead in Upgrading to Biventricular Pacing

Wen-Lieng Lee and Chih-Tai Ting

In recent years, cardiac resynchronization therapy or biventricular pacing has been proved to be effective in alleviating congestive heart failure in 70% of patients. For patients who have bradycardia devices in place before presentation of heart failure and the devices are well before end of life, the RV pacing system can be effectively, efficiently and safely upgraded to bi-ventricular pacing through a bipolar IS-1 Y adaptor converting the single ventricular output of the original pacemaker to dual outlets conjoining the two ventricular leads in parallel. Patients who are successfully upgraded enjoy benefits similar to those of de novo implantation of bi-ventricular pacemaker. At implantation, the pacing threshold of the newly implanted unipolar left ventricular lead should be measured in the Y adaptor-on or LV lead cathode tip to RV anode ring configuration to allow for additional resistance elements.

Key Words: Cardiac resynchronization • Biventricular pacing • Y adaptor • Upgrading • LV lead

In recent years, cardiac resynchronization therapy (CRT) or biventricular pacing has been proved to be effective in alleviating congestive heart failure in 70% of patients, mainly through an endovascularly placed left ventricular lead in the free wall and restoration of atrioventricular, intraventricular and interventricular dyssynchrony.[1] Among those patients clinically indicated, some have received bradycardia devices for a variable period of time before heart failure emerged or progressed to a stage necessitating advanced heart failure therapy. Patients who suffered from severe heart failure a variable period of time after receiving ventricularly based pacemaker after AV junctional ablation therapy for refractory atrial fibrillation with rapid ventricular responses belong to this patient group. Chronic RV pacing does not cause clinical deterioration in individuals with normal ventricular function.[2-4] However, there are reports showing ventricularly based pacemakers per se might induce ventricular dysfunction and secondarily congestive heart failure.[5,6] Recent clinical studies have shown that either atrial-based or less RV pacing is associated with less heart failure, less hospitalization, better quality of life and longer survival.[7-9] Traditional RV apical pacing produces LBBB, right axis deviation and wide QRS complex pattern on 12-lead surface ECG, implying abnormal LV activation sequence. Functionally, it induces paradoxical septal wall motion and decreases in left ventricular ejection fraction, cardiac output and systemic blood pressure.[5,10] RV apical pacing impairs LV systolic, diastolic functions and myocardial perfusion.[11-13] These electrical and functional changes following RV apical pacing are quite analogous to those associated with severe intrinsic LV conduction delay, raising concern for traditional apical RV pacing for patients with pre-existing ventricular dysfunction. Rosenqvist et al. reported a heart failure incidence of 23% after 4 years of ventricular-based pacing for sick sinus disease.[14] Heart failure patients with bradycardiac devices already in place and far beyond device end-of-life should be considered candidates to become

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Division of Cardiology, Department of Medicine, Taichung Veterans General Hospital, Taichung and Department of Medicine, National Yang Ming University School of Medicine, Taipei, Taiwan.
Address correspondence and reprint requests to: Dr. Wen-Lieng Lee, Division of Cardiology, Department of Medicine, Taichung Veterans General Hospital, 160, Sec. 3, Chung-Kang Road, Taichung 407, Taiwan. Tel: 886-4-2359-2525 ext. 3124; Fax: 886-4-2359-9257; Email: wllee@vghtc.vghtc.gov.tw

beneficiaries of the modern biventricular pacing through insertion of a new dedicated device or upgrading the existing system to biventricular pacing with available tools and techniques at least possible cost.

The newer-generation pacemakers used in cardiac resynchronization therapy, such as InSync 8042, have two independent output pores for RV and LV leads, respectively, intended for separate programmable outputs and a spectrum of V-to-V delays to meet the need for different lead thresholds and to adjust the interventricular delay and activation of ventricles, thus optimizing the LV performance. On the other hand, the first-generation pacemakers used for resynchronization, such as InSync 8040, have paired ventricular outputs. These two outputs have shared pulse width and amplitude programming, and combined sensing and lead impedance measurements, materially a Y adaptor implemented at the connection head. Therefore, for patients who have bradycardia devices in place that do not reach end of life before the patient embarks on CRT, the RV pacing can be economically and successfully upgraded to bi-ventricular pacing while not abandoning the originally implanted generators. Using a bipolar IS-1 Y adaptor (such as Medtronic 2872) to convert the single IS-1 bipolar ventricular output pore of the original pacemaker to dual outlets and conjoin in parallel the original RV (unipolar or bipolar) and the newly placed LV (unipolar or bipolar) leads which are introduced into the candidate cardiac vein by standard procedure and techniques, biventricular pacing can be easily achieved at a reasonably low cost. Technically, the upgrading procedure is quite similar to generator exchange or new implantation and is carried out at the cardiac cath lab equipped with standard fluoroscope and under local anesthesia with 1% lidocaine. The upgrading procedure should be preceded by an externally introduced temporary pacing lead in the RV, usually through the femoral vein. Surgical incisions are made along the original suture lines and the chronically implanted pacemaker and lead(s) are identified and freed from surrounding adhering tissues by meticulous tissue dissection and lysis. Then the left subclavian vein is accessed by standard venipuncture technique and a LV lead implanted according to standardized procedure after coronary sinus venogram has been obtained (The details of site selection, choosing LV lead and implanting techniques are introduced in other articles in this same issue of this journal). The original RV lead is disconnected from the generator and re-connected to one arm of the Y adaptor and the LV lead to the other arm. Then the conjoined end is connected to the V pore of the generator. The procedure is finished off with the generator reimplanted to the original pocket and the wound sutured. Usually the patients can be discharged home the next day. Leon et al. reported successful upgrading of their

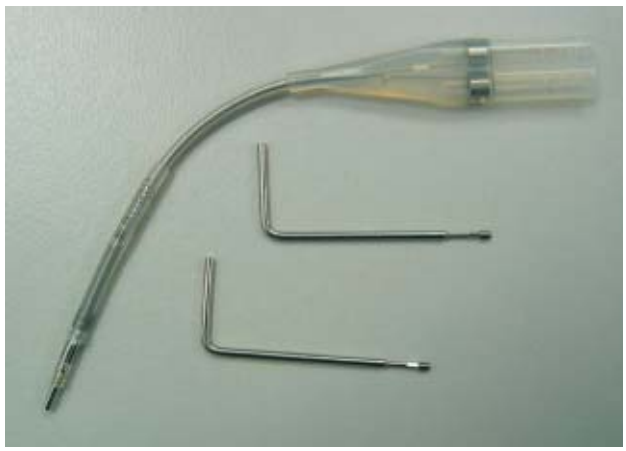

Figure 1. *Picture of a Y adaptor (Medtronic 2872).*

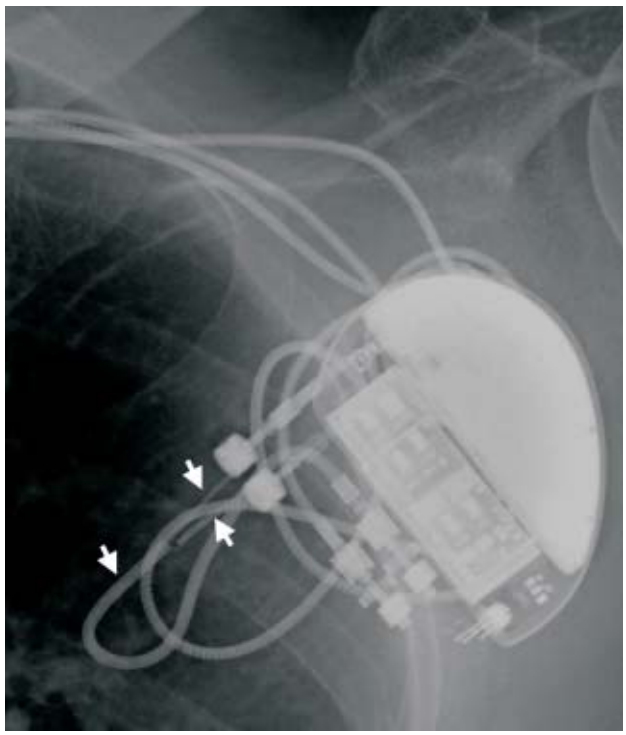

Figure 2. *Enlarged roentgenograph of the dual-chambered generator (Pacesetter xx) upgraded to a bi-ventricular system by using a Y-adaptor. Arrows indicate the three arms of the adaptor.*

heart failure patients from right ventricular pacing a period of time after prior AV junction ablation for refractory atrial fibrillation to biventricular pacing using the implanted pacemaker and a Y adaptor. Patients who are successfully upgraded have less hospitalization due to congestive heart failure, lower heart failure functional class, smaller heart chamber size and higher left ventricular ejection fraction, to the same extent as de novo implantation.[15] In the MUSTIC (MUultisite STimulation In Cardiomyopathy) study, de novo biventricular pacing was also shown to be effective in patients with atrial fibrillation, improving 6-minute walk distance, peak VO2, quality of life, and heart failure functional class.[16] Prospective clinical study looking at the effect of left ventricular-based cardiac stimulation post AV nodal ablation for refractory Af (PAVE Trial) is still ongoing. Unilateral subclavian venous thrombosis due to existing lead(s) might impede the introduction of a new lead and demand starting a new system from the contralateral side. The upgrading was reported to be associated with a successful rate of around 90%, a low complication rate and could be accomplished in reasonable procedural time.[17] Thus, modification of the original RV pacing to a biventricular system could be effectively, efficiently, and safely achieved using commercially available leads and adaptors.

Several different biventricular pacing configurations can be used in the upgraded system, depending on the polarities of the original RV leads and newly introduced LV leads. Upgrading to biventricular pacing using a Y adaptor and the previously implanted devices does deserve special consideration at implantation if a new unipolar LV lead which shares the common anode ring of the bipolar RV lead is used. The pacing threshold of a unipolar left ventricular lead might be higher when tested in the Y adaptor-on configuration (LV lead cathode tip to RV lead anode ring) in comparison with the threshold measured unipolarly (LV lead tip to subcutaneous tissue). This is not due to RV lead current shunting in case of low RV lead resistance. In the in vivo status, the unipolar LV lead pacing threshold is affected by RV ring (anode) surface area, lead polarization at the tissue-electrode interface and transmyocardial impedance (spacing). The mean in vivo measured additional resistance was about 100-150 ohm (25 - 162 ohm, average 122 ± 79).[18] Therefore, the LV lead threshold at the upgrading should be measure in the LV tip to RV ring configuration or the combined tip to shared RV ring configuration through the Y adaptor. If ignored, threshold measured in the follow-up may be unacceptably high and lead revision or generator replacement required.[18]

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