A Case of Useful Short-Spaced Bipolar Pacing of a Left Ventricular Lead to Avoid Phrenic Nerve Stimulation

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Summary
A 48-year-old woman underwent cardiac resynchronization therapy defibrillator implantation. Coronary sinus (CS) venography showed only one adequate anterior branch for a left ventricular lead. We were able to introduce a quadripolar left ventricular lead (Medtronic 4398-88 cm) to the distal portion of the anterior branch. Although phrenic nerve stimulation (PNS) occurred due to distal bipolar pacing (distal 1-mid 2, with 21-mm distance) and proximal pacing (mid 3-proximal 4, distance 21mm), short-spaced bipolar pacing (mid 2-3, distance 1.3 mm) did not induce PNS until 9V pacing. Shared bipolar pacing from each left ventricular electrode (distal 1 to proximal 4) as cathode and a right ventricular (RV) coil as anode resulted in PNS by 3.0V at 0.4 ms. Although quadripolar pacing could avoid PNS by switching the pacing site (ie, from distal bipolar to proximal bipolar), it might not avoid PNS in cases where the phrenic nerve and CS branch are parallel and in close proximity. We found that even though the phrenic nerve and CS branch were parallel and close, short-spaced bipolar pacing could avoid PNS. In conclusion, short-spaced bipolar pacing selected by quadripolar pacing might be beneficial to avoid PNS when the implantable branch is limited. (Int Heart J 2016; 57: 118-120)

Key words: Cardiac resynchronization therapy, Interelectrode spacing

Heart failure that is resistant to optimal medical therapy remains a major problem in cardiovascular medicine. In cases of heart failure with cardiac dyssynchrony, cardiac resynchronization therapy (CRT) is often used. Phrenic nerve stimulation (PNS) is a major problem in implantation of CRT. A unipolar or bipolar lead might have to be implanted more proximally in a vein to avoid PNS and be at increased risk of dislodgement. Quadripolar leads can be implanted distally in the coronary sinus (CS) branch by using a proximal electrode for pacing in a location with acceptable electrical parameters to avoid PNS. However, quadripolar leads cannot escape from PNS when the phrenic nerve and CS branch are parallel and close. We report a case in whom we could avoid PNS by using short-spaced bipolar pacing.

CASE REPORT
A 48-year-old woman was referred to our hospital due to syncope. Her electrocardiogram showed ventricular fibrillation, and her consciousness was recovered by two automated external defibrillator shocks. Left ventricular (LV) ejection fraction was 16% and QRS duration was 177 ms with left bundle branch block. She underwent CRT-defibrillator (CRT-D) implantation. After implantation of the right atrial lead and shock lead, CS venography was performed. The venography showed only one adequate anterior branch to introduce LV lead (Figure 1), and we planned to introduce an LV lead to the branch. We could introduce an LV lead (Medtronic 4398-88 cm) to the distal edge of the anterior branch, and tested the pacing threshold and PNS threshold (Figure 2).

Although PNS occurred by distal bipolar pacing (distal 1-mid 2) and proximal pacing (mid 3-proximal 4) (5.0V at 0.4 ms, and the pacing threshold was 2.5V at 0.4 ms), mid short-spaced bipolar pacing (mid 2-3) did not induce phrenic nerve stimulation until 9V pacing (the pacing threshold was 1.5V at 0.4 ms). We attempted to use a right ventricular coil as an anode, however, the pacing of all distal electrodes (distal 1 to proximal 4) as cathode resulted in PNS by 3.0V at 0.4 ms.

She was discharged without any other complications. Three months later, we checked her PNS and pacing threshold. When we used the right ventricular coil as a proximal electrode, the pacing of all distal electrodes (distal 1 to proximal 4) still resulted in PNS by 3.0V at 0.4 ms. However, PNS never occurred by distal bipolar pacing (distal 1-mid 2) or proximal pacing (mid 3- proximal 4) by 3.0V at 0.4 ms. X-rays showed a significant reduction of the cardio-thorax ratio (Figure 3).
CRT is associated with a number of difficulties, including nonresponders, lead/pocket trouble, and PNS. The incidence of non-reprogrammable PNS has been reported as 1%. The problem is sometimes serious enough to require reoperation, and the use of multipolar leads and multiple pacing configurations are a useful option to avoid reoperation. The frequency of PNS with implanted LV leads is higher in the posterior and lateral branch, however, implanted LV leads in the anterior branch also result in PNS. Although quadripolar pacing can avoid PNS by switching the pacing site (ie, from distal bipolar to proximal bipolar), it cannot avoid PNS when the phrenic nerve and CS branch are parallel and close. Changing the pacing polarity between different pacing sites (LV tip/ring versus LV tip/RV coil) is a useful option to avoid PNS, however, the method failed in our case. We showed that even if the phrenic nerve and CS branch were parallel and close, short spaced bipolar pacing may avoid PNS. Biffi, et al showed that short spaced LV pacing resulted in an increase of PNS. In the present case, the usual bipolar LV pacing did not result in PNS 3 months later. We speculate that the change in the size of her heart resulted in separation of the CS branch from the phrenic nerve.
In conclusion, short-spaced bipolar pacing selected by quadripolar pacing might be beneficial to avoid PNS when an implantable branch is limited.

**Disclosures**

The authors have no conflicts of interest to disclose.

**References**