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Case report

Left ventricular septal pacing – can we trust the ECG?

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ABSTRACT

In contrast to left bundle branch pacing, the criteria for left ventricular septal pacing (LVSP) were never validated. LVSP is usually defined as deep septal deployment of the pacing lead with a pseudo-right bundle branch morphology in V1. The case report describes an implant procedure during which this definition of LVSP was fulfilled in four of five pacing locations within the septum, with the shallowest of them present in less than 50% of the septal thickness. The case highlights the need for a more precise definition of LVSP.

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A 73-years old patient was admitted after syncope due to intermittent 3rd-degree AV block. He was otherwise healthy, had a narrow QRS, and presented with normal echocardiography with a septal thickness of 11 mm. A permanent pacemaker with left bundle branch pacing was recommended. The patient understood the nature of the procedure and signed informed consent. During implantation, the ventricular pacing lead was placed at a depth of approximately 13 mm into the septum, and LBB left posterior fascicle capture was observed. The surgeon decided to provide LBBP with a normal heart axis, and the second lead was placed more basally and superiorly to the first – Fig. 1, Panel A. At a depth of 12 mm, a far-field left bundle branch potential (LBBpo) appeared, and LVSP was recognized during pacing. nsLBBP was obtained only when pacing with the output of 10V at 0.5 ms - Fig. 1, Panel B. A "drilling effect" (i.e., no further penetration with additional lead rotations) prevented advancing the superior lead deeper into the septum, and it was decided to use the inferior lead for permanent pacing. The superior lead was then gradually withdrawn from the septum, and temporary pacing was performed at various depths with pacing outputs of 5V and 1V at 0.5 ms. The paced ECG and EGM signals were recorded along with X-ray images of the depth of the lead in the septum for each pacing location. The depth of the lead was verified using dye injections at each pacing site – Fig. 2.

Five septal pacing positions at various depths were noted, four of which, at lead depths of 12, 10, 8, and 6 mm, had a pseudo-right bundle branch morphology in V1 – Fig. 2, Panels A–D. No significant changes in QRS morphologies and V6RWPT were noted while pacing at 5V and 1V at any of these pacing locations. However, the amplitude of the late r/R in V1 gradually decreased, V6RWPT prolonged, and V6–V1 interpeak interval shortened as the lead progressed to shallower pacing positions. Finally, the pseudo-right bundle branch morphology disappeared at a depth of 5 mm. This pacing location presented with a QS pattern in V1 and the shortest V6RWPT – Fig. 2, Panel E.

LBBP and LVSP have recently appeared as physiological alternatives to His bundle pacing. In contrast to LBBP, which is defined as the capture of the LBB trunk or its proximal fascicles [1], the criteria for LVSP have never been validated. Usually, LVSP is characterized by deep septal deployment of the pacing lead with a pseudo-right bundle branch block morphology in V1 [2]. As shown in the case described above, four of five septal pacing locations with different lead depths fulfilled the criteria for LVSP. Moreover, the pseudo-right bundle branch block morphology pattern in V1 was still present at a depth of 6 mm, i.e., 50% of the distance to the location where nsLBBP capture was possible. It points to the fact that the presence of the r/R in V1 may not be an optimal marker of LVSP because it only reflects that RV activation was more delayed than LV activation [3]. Similarly, a right bundle branch block-like pattern is not specific for any pacing location, since it can also be observed during deep septal pacing [4], pacing from other right ventricular sites [5,6], and also depends on the position of V1 lead on the chest surface [5].

Another important question is, which pacing location should be specific for LVSP? In a study by Salden et al., an electrophysiological catheter placed in the LV cavity to pace the LV endocardium was

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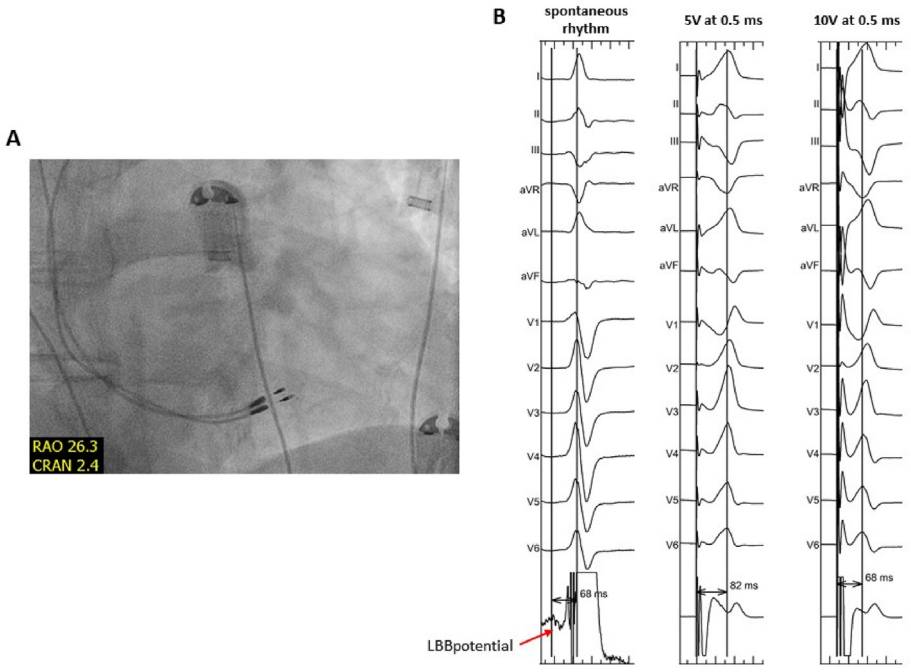

Fig. 1. Panel A – visualization of pacing lead positions in the RAO projection. Panel B–a far-field LBBpo (red arrow) was present on the upper lead, with LVSP occurring when pacing with outputs between 1V and 5V at 0.5 ms and nsLBBP when pacing with an output of 10V at 0.5 ms.

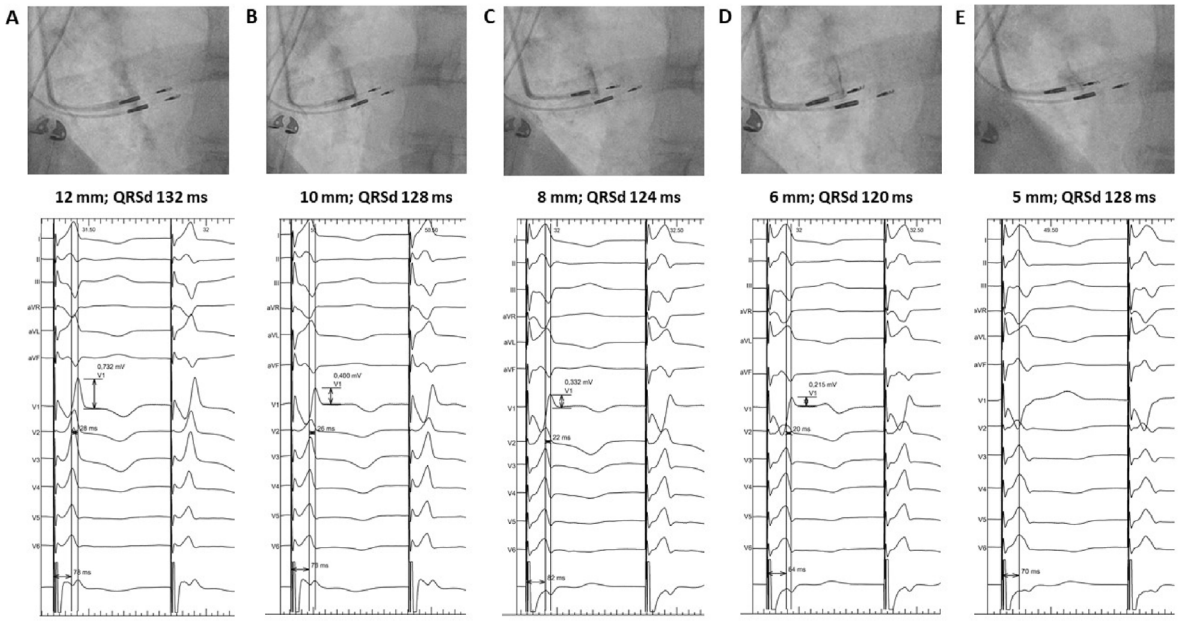

Fig. 2. The changes in the QRS morphologies, V6RWPT, amplitudes of late r/R in V1 and V6–V1RWPT differences are displayed at various depths of the lead tip inside the septum.

used for LVSP [7].In a report from Mafi-Rad et al., the LVSP pacing location was not specified, and of the ten cases included, only one patient with late r in V1 was shown as an example of LVSP [8]. As was recently published, a late r in V1 can be produced by leads at various depths within the interventricular septum [9,10]. Also, UHF-ECG studies of ventricular activation patterns showed that LVSP with a late r/R or rs in V1, resulting from pacing at 66–80% of the septal thickness, resulted in worse LV activation than nsLBBP. In contrast, LVSP close to LBB (i.e., LVSP, which transitioned from nsLBBP during decremental output pacing) had identical LV activation patterns as nsLBBP [3,11].

New pacing techniques such as HBP, LBBP, and LVSP entered clinical practice to improve clinical outcomes in patients with pacemakers. The criteria for LVSP have never been validated and rely on deep septal deployment of the pacing lead with a presence of late r/R in V1 during pacing. Our case report describes an implant procedure during which this definition of LVSP was fulfilled in four of five pacing locations within the septum. The shallowest lead was at a depth of less than 50% of the septal thickness, highlighting the need for a more precise definition of LVSP.

V6RWPT – time difference between pacing artifact and maximal amplitude of the QRS complex in lead V6; V6–V1RWPT – the difference between the maximal amplitudes of the QRS complexes in lead V6 and V1; the amplitude of late r/R n V1 was measured from the V1 isoline.

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Declaration of competing interest

Authors disclose no conflict of interest relevant to the manuscript.

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