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Combined therapy with subcutaneous implantable cardiac defibrillator and leadless pacemaker in a patient with persistent left superior vena cava and mega coronary sinus: A challenging case for the best treatment

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1 | INTRODUCTION

Persistent left superior vena cava (PLSVC) has a prevalence of ≈0.5% in the general population. In some rare cases, it has been described as occasional intra-operatory finding during pacemaker or implantable cardiac defibrillator (ICD) implant. Depending on the patient's anatomy, the implantation of right ventricular lead may be troublesome and sometimes it is not achievable. In a patient with such very difficult anatomy requiring ICD therapy, in the absence of the need for pacing, subcutaneous ICD (S-ICD) represents the gold standard. This approach proved to be effective and safe. However, when the same patient develops also a conduction disorder, leadless pacemaker implant may be the optimal solution. Indeed, leadless pacemaker has been proposed as an alternative and effective pacing therapy in patients with limited venous anatomy. An appropriate programming of both devices represented the technical challenge in order to avoid inappropriate shocks due to leadless pacing oversensing.

2 | CASE REPORT

A 78-years old male with permanent atrial fibrillation and chronic ischemic heart disease was admitted to our Hospital due to syncope. The ECG showed atrial fibrillation with a mean heart rate of 110 bpm and left axial deviation. The echocardiography showed a normal ejection fraction, moderate aortic stenosis, and mega coronary sinus (Figure 1A). The coronary angiography did not demonstrate a progression of coronary artery disease. Patient was on a maximally tolerated dose of beta-blocker (metoprolol 50 mg twice daily). During hospitalization, some episodes of extreme bradycardia and ventricular tachycardia, both symptomatic for presyncope, were showed and recorded on the monitor (Figure 1B,C). Aortic valve replacement was considered by Heart Team as not indicated. Therefore, the indication of ICD implantation as secondary prevention was given. During the procedure, a PLSVC draining into the mega coronary sinus was found and the absence of right superior vena cava was also observed (Figure 2A,B). Several but unsuccessful attempts at fixating defibrillator lead in the right ventricle with conventional (Medtronic 6935M-62) and unconventional (Medtronic 6935M-97) lengths, as well as stiff stylets with modified curves, were performed through the left subclavian venous access.

As a consequence, combined therapy with Emblem S-ICD (Boston Scientific Corp) and Micra leadless pacemaker (Medtronic Inc) was chosen as the best solution in order to avoid epicardial pacemaker implant. The screening test of S-ICD was passed with

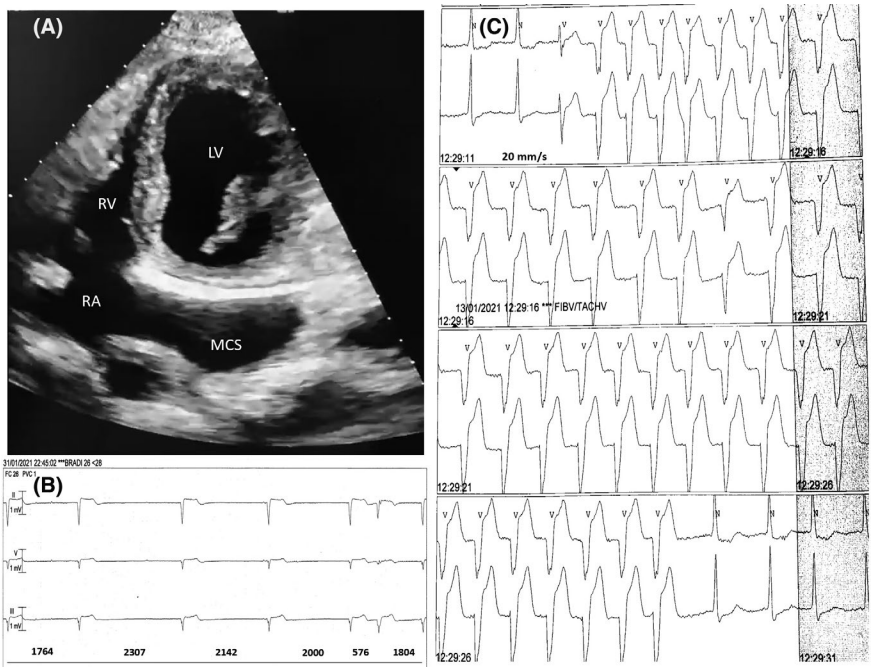

FIGURE 1 Echocardiography showing mega-coronary sinus entering the right atrium (A); Symptomatic bradycardia (B) and ventricular tachycardia with HR 130 bpm (C) recorded on monitor. LV, left ventricle; MCS, mega-coronary sinus; RA, right atrium; RV, right ventricle. Inter-beat intervals are expressed in milliseconds

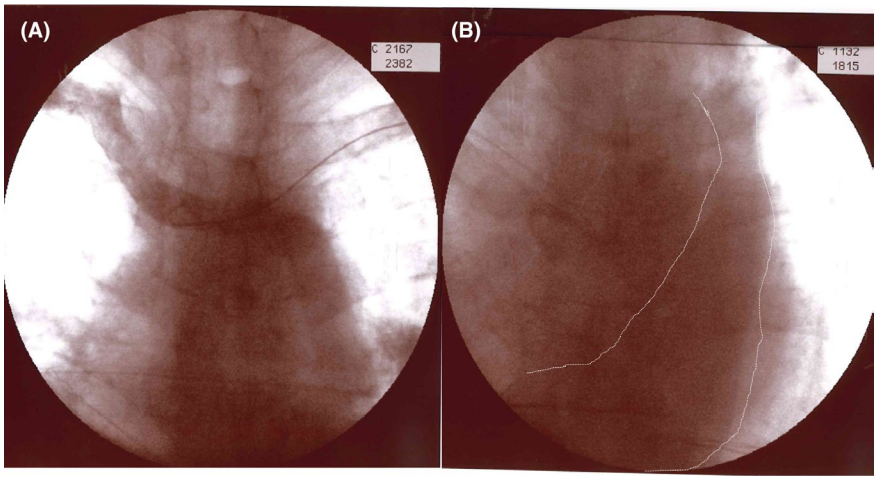

FIGURE 2 Venography from the right superior arm, with guidewire advanced from the left subclavian vein, showing the absence of right superior vena cava and the presence of persistent left superior vena cava (A) draining in the mega coronary sinus (B: dashed white line)

all primary, secondary and alternative vectors, both in supine and orthostatic position, and the device was therefore implanted. Defibrillation test (DFT) was performed demonstrating correct VF detection followed by effective shock with a subsequent episode of prolonged episode of Brady-asystole with spontaneous resolution. Few days later, the leadless pacemaker with a transfemoral approach was successfully implanted on the interventricular septum (Figure 3A,B). During implantation and before the definitive release of leadless pacemaker, S-ICD sensing on primary, secondary, and alternative vectors were checked throughout pacing. None of the three vectors showed T-wave oversensing or double counting and the evaluation of S-ICD sensing in all three vectors was optimal both in spontaneous rhythm and paced rhythm (Figure 3C,D). S-ICD was programmed with a dual zone configuration: a conditional shock zone of 180 bpm and a shock zone of 250 bpm; the primary vector was chosen as sensing vector, the gain used was x1, the shock polarity was standard (coil to can) and the SMART-pass algorithm was turned on. As the patient had a spontaneous heart rate of about 70 bpm, the template was acquired in spontaneous rhythm. The leadless pacemaker was programmed as a backup in VVI modality with a lower rate of 50 bpm. The patient is currently followed by home monitoring and VT catheter ablation will be considered during follow-up if recurrent episodes of symptomatic VT may occur.

3 | DISCUSSION

The S-ICD has been routinely used for 10 years and it is recommended in class I and IIa by current guidelines (ESC, AHA, ACC,

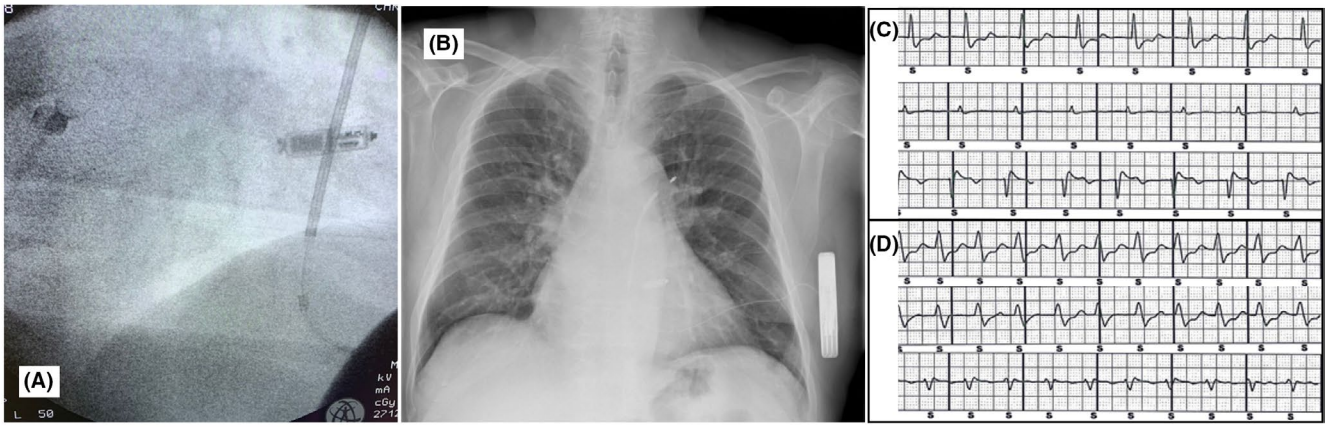

FIGURE 3 Leadless pacemaker implantation; on the left of the delivery system, in the middle of the image, in parasternal position, is the defibrillator lead of S-ICD system (A); definitive antero-posterior chest X-ray showing position of both devices (B). Spontaneous sensed beats by S-ICD (from top to the bottom primary, secondary and alternative vector) (C); Paced sensed beats by S-ICD (from top to the bottom primary, secondary and alternative vector) (D)

HRS) in order to prevent sudden cardiac death in patients with a high risk of infection, inadequate venous access, and any patient without a pacing indication. The safety and efficacy of S-ICD diagnostic capacity and therapy are well known (eg, results from the recently published Pretorian Trial). In order to ascertain the presence of a good sensing vector, a screening test is always performed before S-ICD implantation. DFT after ICD implantation does confirm both the correct recognition of the arrhythmia and the effectiveness of the shock. However, a major concern during combined therapy with S-ICD and leadless pacemaker may be represented by a possible change of the heart vector during pacing that could lead to double counting of T wave and inappropriate shocks. The first report of such combined therapy in humans was described by Mondésert et al about six years ago and, to date, the hybrid therapy with S-ICD and leadless pacemaker has been occasionally described. Beyond technical implantation difficulties, programming of S-ICD may be unsuccessful in patients with both these cardiac implantable electronic devices in situ. This challenging condition has been overcome by carrying out the best programming of S-ICD. Choosing the best sensing vector is the first condition and when necessary, if sensing is too poor, it is possible to increase the gain. Secondary, a dual zone configuration allows to discriminate heart rhythm in the "conditional zone," below the threshold of shock zone. The conditional shock zone uses a stepwise discrimination algorithm to distinguish shockable from non-shockable rhythms and performs a morphology analysis process that is based on a normal rhythm transthoracic QRS:T wave template. A poor match to the static QRS:T morphology template moves the algorithm to a dynamic waveform analysis that compares single beat morphologies. If a tachycardia has a prolonged QRS width compared to the template width and is of sufficient duration, then it will lead to a shock. This is the reason why it is extremely important to acquire a baseline template and eventually to update it during the outpatient follow-up. Moreover, in order to minimize T-wave oversensing on S-ICD, it is possible to apply the SMART-pass algorithm that uses a high-pass filter of 9 Hz and has been shown to reduce by 71% the inappropriate shocks due to oversensing. As far as the leadless pacemaker management is concerned, positioning the pacemaker on interventricular septum is desirable during the implant in order to avoid oversensing on S-ICD due to pacing. In addition, if oversensing occurs, programming the pacemaker in VVI modality with only a backup lower rate of 50 bpm, would definitely reduce the probability of inappropriate shocks. Of additional concern may be the possible damage of the leadless pacemaker during S-ICD treatment. However, available literature data do not show any abnormality detectable after shock delivery.

4 | CONCLUSIONS

Cardiac device therapy is expected to be further revolutionized by a combination of S-ICD and lead-less pacemaker, therefore, representing the next step in the optimal device rhythm management of complex patients. In the next future, the communication between leadless pacemaker and a S-ICD is expected in order to achieve a combined function of anti-tachycardia pacing by leadless pacemaker through modular cardiac rhythm management. Several pre-clinical studies on animals have proved appropriate VVI functionality, successful wireless device–device communication, and ATP delivery. However, before clinical adoption can be considered, long-term performance results and human clinical studies are required. Based on these considerations, it is not surprising that, as soon as increasing scientific evidences will be available, this approach may be considered in the future as a gold standard in some particular cases.

DISCLOSURE

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CONFLICT OF INTEREST

The authors declare no conflict of interests for this article.

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