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Multi-site multi-polar left ventricular pacing through persistent left superior vena cava in tricuspid valve disease

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ABSTRACT

Multi-site multi-polar left ventricular pacing through the coronary sinus (CS) may be preferred over endocardial right ventricular or surgical epicardial pacing in the presence of tricuspid valve disease. However, the required lead placement can be difficult through a persistent left superior vena cava (PLSVC), as the CS tends to be hugely dilated and side branches tend to have sharp angulations (>90°) when approached from the PLSVC. Pre-shaped angiography catheters and techniques used for finding venous grafts from the ascending aorta post coronary bypass surgery may help with lead placement in such a situation.

1. Introduction

Reliable ventricular pacing can be achieved without involving the tricuspid valve (TV), the endocardial surface of the right ventricle (RV) or cardiac surgery by placing 2 leads into the middle cardiac vein (MCV) and another side branch of the coronary sinus (CS) [1]. However, multi-site left ventricular (LV) pacing can be challenging to achieve through a persistent left superior vena cava (PLSVC), as the CS tends to be hugely dilated, side branches tend to have sharp angulations (>90°) when approached from the PLSVC, and a lead has to change from going with the physiological direction of blood flow in the PLSVC into against the physiological direction of blood flow in the side branch [2,3]. (In contrast, a lead placed through the CS os into a side branch consistently moves against the physiological direction of blood flow.) A case of multi-site LV pacing through a PLSVC in TV disease is presented.

2. Case history

A 47 year old man with a PLSVC developed complete heart block after TV repair with an annuloplasty ring for severe regurgitation. Multi-site LV pacing through the CS was preferred over transvenous endocardial RV or surgical epicardial pacing. An active fixation pacing lead (Tendril STS 2088TC 52cm; Abbott, Sylmar, CA, USA) was positioned through the PLSVC onto the right atrial (RA) wall without much difficulty. The CS was hugely dilated and could not be adequately opacified by direct contrast injection through the guide catheter (CPS Direct SLII DS2C003 135, Abbott). A balloon catheter passed through the PLSVC would not help as the catheter tip would be closer to the CS os than the balloon.

Through trial and error, a 5F Amplatz AL1 angiography catheter (Infiniti 534545T, Cordis, Milpitas, CA, USA) engaged the MCV. Contrast venography of the MCV outlined an antero-lateral side branch faintly through retrograde filling, but its origin from the main CS was not clearly seen (Fig. 1a). The AL1 angiography catheter was exchanged for an Amplatz AL2 sub-selection catheter (CPS AIM SL DS2N025-65, Abbott) to provide a conduit for a quadripolar LV lead (Quartet 1458Q 86cm, Abbott) into the MCV. The distal 2 electrodes could not achieve LV capture up to 5V@0.4ms despite exhausting all the pacing vectors involving them. The proximal 2 electrodes achieved LV capture with a best threshold of 1.5V@0.4ms. As soon as the sub-selection catheter was slit, the lead prolapsed out of the MCV. The quadripolar LV lead was repositioned, but the sub-selection catheter was slit with extra lead length continuously fed into RA. A large loop of the lead skirted around the entire RA, but its distal end stayed in the MCV (Fig. 1b).

The ostium of the antero-lateral side branch from the CS was eventually engaged with a 5F Judkins JR6 catheter (Infiniti 534525T, Cordis), after an AL1 (Infiniti 534545T), a Judkins JR4 (Infiniti 534521T) and an internal mammary (IM LBT 556-190-0L) catheters

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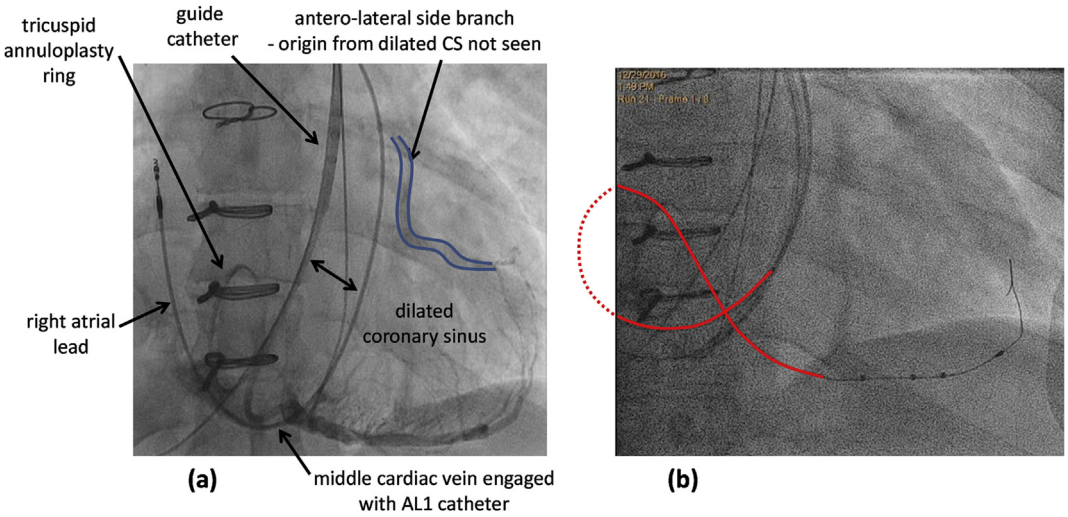

Fig. 1. Contrast venogram of the middle cardiac vein and lead course after slitting of sub-selection catheter. (a) The coronary sinus (CS) was hugely dilated, as reflected by the wide separation between the guide catheter and the right atrial lead. An Amplatz AL1 angiography catheter was used to engage the ostium of the middle cardiac vein (MCV). Retrograde filling from the MCV outlined an antero-lateral side branch faintly, but its origin from the main CS body was not clearly seen. (b) As soon as an Amplatz AL2 sub-selection catheter was slit, the quadripolar left ventricular lead immediately formed a large loop in the right atrium without disturbing the distal lead tip position. Any slight reduction of the loop caused the lead tip to move basally out of the MCV.

had been tried. A 0.014″ angioplasty guide wire was manipulated into the side branch, providing a rail for the JR6 and then the guide catheter to follow. The JR6 catheter was taken out of the guide catheter and exchanged for a bipolar LV lead (QuickFlex μ 1258T, Abbott), which passed easily into the side branch and achieved good electrical parameters (Fig. 2). After the guide catheter was slit, the bipolar LV lead retracted to a slightly more proximal position in the side branch but remained electrically functional. The bipolar LV lead was plugged into the RV port of a cardiac resynchronisation therapy (CRT) pacemaker (Quadra Allure MP™ RF, PM3262, Abbott, Fig. 3). At 3 months follow-up, both the patient and the pacing system were doing well.

3. Discussion

Endocardial leads crossing the TV can damage (through stenosis or regurgitation) [4–13] and be damaged by (through insulation abrasion [11,14] or conductor fracture [15]) the valve, especially after surgical correction of severe pre-existent disease [16]. Tricuspid regurgitation is more common and severe in the presence of transvenous leads, and is then associated with increased mortality [17–19]. Epicardial leads require invasive pericardial intervention or surgery for placement and may not be as reliable as endocardial leads (rising pacing threshold, insulation breach and conductor fracture) over time [20]. Transvenous epicardial LV pacing through the CS suffers less from these issues, but has its own drawbacks from lack of suitable side branches, lead dislodgement, phrenic nerve stimulation, and less reliable pacing and sensing characteristics [21,22].

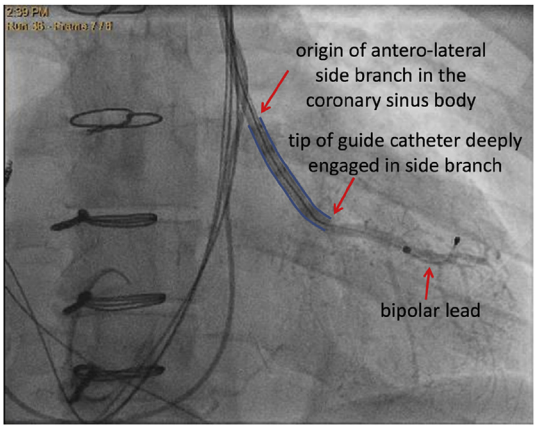

Fig. 2. Direct engagement of an antero-lateral side branch of the coronary sinus through persistent left superior vena cava. The origin of antero-lateral side branch from the coronary sinus was not well visualized by cross-filling from the middle cardiac vein. The side branch was only partially engaged with a Judkins JR6 catheter after trying multiple other angiography catheters. An angioplasty guide wire manipulated into the side branch provided enough support for the JR6 and then the guide catheter to enter the branch, allowing a bipolar lead to be placed within.

Quadripolar LV leads offer many extra pacing options than bipolar LV leads [23], reducing the need for compromise among positional stability, phrenic nerve stimulation and capture threshold, and are associated with fewer complications [24–27]. In this case, the proximal 2 electrodes of the quadripolar lead in the MCV provided pacing while the distal 2 electrodes provided anchorage. If only 2 electrodes were available (as for a bipolar LV lead) and they had to serve both pacing and anchorage, the lead would very likely have dislodged. Quadripolar leads may produce extra haemodynamic and clinical benefits through multi-point pacing [28–31], but can only be used with CRT devices, which still exclusively employ the bipolar RV channel for the timing cycle. Thus a bipolar lead needs to be inserted into another side branch of the CS along with the quadripolar lead in the MCV.

The bipolar LV lead in this case retracted slightly from its intended position in the antero-lateral side branch after the guide catheter had been slit. The antero-lateral side branch was probably too short for a quadripolar lead, and its 2 most proximal electrodes would likely have stayed outside the side branch in the main CS body had it been used. An alternative strategy to solving the compromise among positional stability, phrenic nerve stimulation and capture threshold is to have an active fixation mechanism on the lead body. An early embodiment of such a design concept is a unipolar lead with deployable side loops (Attain Starfix 4195, Medtronic, Minneapolis, MN, USA), which would not be suitable in this patient as the PLSVC might be torn if the lead ever needed to be

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