Assessment of exit block following pulmonary vein isolation: Far-field capture masquerading as entrance without exit block

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BACKGROUND Complete electrical isolation of pulmonary veins (PVs) remains the cornerstone of ablation therapy for atrial fibrillation. Entrance block without exit block has been reported to occur in 40% of the patients. Far-field capture (FFC) can occur during pacing from the superior PVs to assess exit block, and this may appear as persistent conduction from PV to left atrium (LA).

OBJECTIVE To facilitate accurate assessment of exit block.

METHODS Twenty consecutive patients with symptomatic atrial fibrillation referred for ablation were included in the study. Once PV isolation (entrance block) was confirmed, pacing from all the bipoles on the Lasso catheter was used to assess exit block by using a pacing stimulus of 10 mA at 2 ms. Evidence for PV capture without conduction to LA was necessary to prove exit block. If conduction to LA was noticed, pacing output was decreased until there was PV capture without conduction to LA or no PV capture was noted to assess for far-field capture in both the upper PVs.

RESULTS All 20 patients underwent successful isolation (entrance block) of all 76 (4 left common PV) veins: mean age 58 ± 9 years; paroxysmal atrial fibrillation 40%; hypertension 70%, diabetes mellitus 30%, coronary artery disease 15%; left ventricular ejection fraction 55% ± 10%; LA size 42 ± 11 mm. Despite entrance block, exit block was absent in only 16% of the PVs, suggesting persistent PV to LA conduction. FFC of LA appendage was noted in 38% of the left superior PVs. FFC of the superior vena cava was noted in 30% of the right superior PVs. The mean pacing threshold for FFC was 7 ± 4 mA. Decreasing pacing output until only PV capture (loss of FFC) is noted was essential to confirm true exit block.

CONCLUSIONS FFC of LA appendage or superior vena cava can masquerade as persistent PV to LA conduction. A careful assessment for PV capture at decreasing pacing output is essential to exclude FFC.

KEYWORDS Atrial fibrillation; Radiofrequency ablation; Pulmonary veins

ABBREVIATIONS **AF** = atrial fibrillation; **LA** = left atrium; **LAA** = left atrial appendage; **LSPV** = left superior pulmonary vein; **PV** = pulmonary vein; **RA** = right atrium; **SVC** = superior vena cava

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Introduction

Complete electrical isolation of pulmonary veins (PVs) remains the cornerstone of ablation therapy for atrial fibrillation (AF).[1] Radiofrequency catheter ablation methodology has evolved from ablating the triggers within the PVs to segmental isolation of PVs to circumferential isolation of ipsilateral veins.[2–3] More than 40% of the PVs demonstrate conduction from PV to left atrium (LA) after achieving entrance block as demonstrated by pacing from bipoles of the circular mapping catheter placed in the PV.[4] PV isolation by using bidirectional conduction block as an end point has been reported to increase long-term success rates. We observed some challenges in assessing exit block due to far-field capture masquerading as conduction from PV to LA. The aim of our study was to present our observations to facilitate accurate assessment of exit block.

Methods

Twenty consecutive patients with symptomatic paroxysmal (45%) or persistent AF (55%) referred for ablation of symptomatic drug-refractory AF were included in the study. All patients with paroxysmal and persistent AF had recurrent episodes within the past 3 months. Patients had failed a mean of 1.5 ± 0.9 antiarrhythmic agents prior to ablation. All patients underwent transesophageal echocardiography and cardiac computed tomography to assess LA thrombus, and PV anatomy, prior to the ablation procedure.

All procedures were performed under general anesthesia. A decapolar (2-8-2 mm spacing) catheter was positioned in the coronary sinus via the left femoral vein. Intracardiac echocardiography (AcuNav; Siemens, Mountain View, CA) catheter was placed in the right atrium (RA) and was used to reconstruct LA and PVs in addition to assessment of the

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position of the Lasso (Biosense Webster, Diamond Bar, CA) catheter in the PVs. Two transseptal punctures were performed, and a 3.5-mm tip, NaviStar–Thermocool irrigated mapping/ablation catheter (Biosense Webster) and a variable diameter (15–25 mm, 2-6-2 mm spacing) Lasso circular 20-pole catheter were advanced to the LA for mapping and ablation. Three-dimensional electroanatomic maps created by the ICE and the mapping catheters were merged (CartoSound, CartoMerge; Biosense Webster) with the 3-dimensional reconstructed image of LA and PVs obtained from the cardiac computed tomography. Wide circumferential linear ablation was performed around the ipsilateral PVs at least 5 mm from the ostia of the veins. If the veins were not isolated following the completion of the circular lesion set, additional lesions were placed along the line by identifying the earliest breakthrough to ensure complete isolation resulting in entrance block. In patients with persistent AF, additional ablation of complex fractionated electrograms and linear ablation were performed. If sinus rhythm could not be achieved, cardioversion was performed.

Electrical isolation of PVs was reassessed in sinus rhythm. Once PV isolation was confirmed (entrance block), pacing from all the bipoles on the Lasso catheter was used to assess exit block by using a pacing stimulus of 10 mA at 2 ms. The Lasso catheter was typically placed just beyond the ostium of the PV and fully expanded so that full circumferential contact was established in the vein. Evidence for PV capture without conduction to LA was necessary to prove exit block. If conduction to LA was noted, pacing output was decreased until there was PV capture without conduction to LA or no PV capture was noted to assess for far-field capture in both the upper PVs. In addition, during the assessment of PV-LA conduction, a catheter was moved to the superior vena cava (SVC) and/or RA or the left atrial appendage (LAA) to assess local capture. If no PV capture or conduction to LA was noted, pacing output was increased

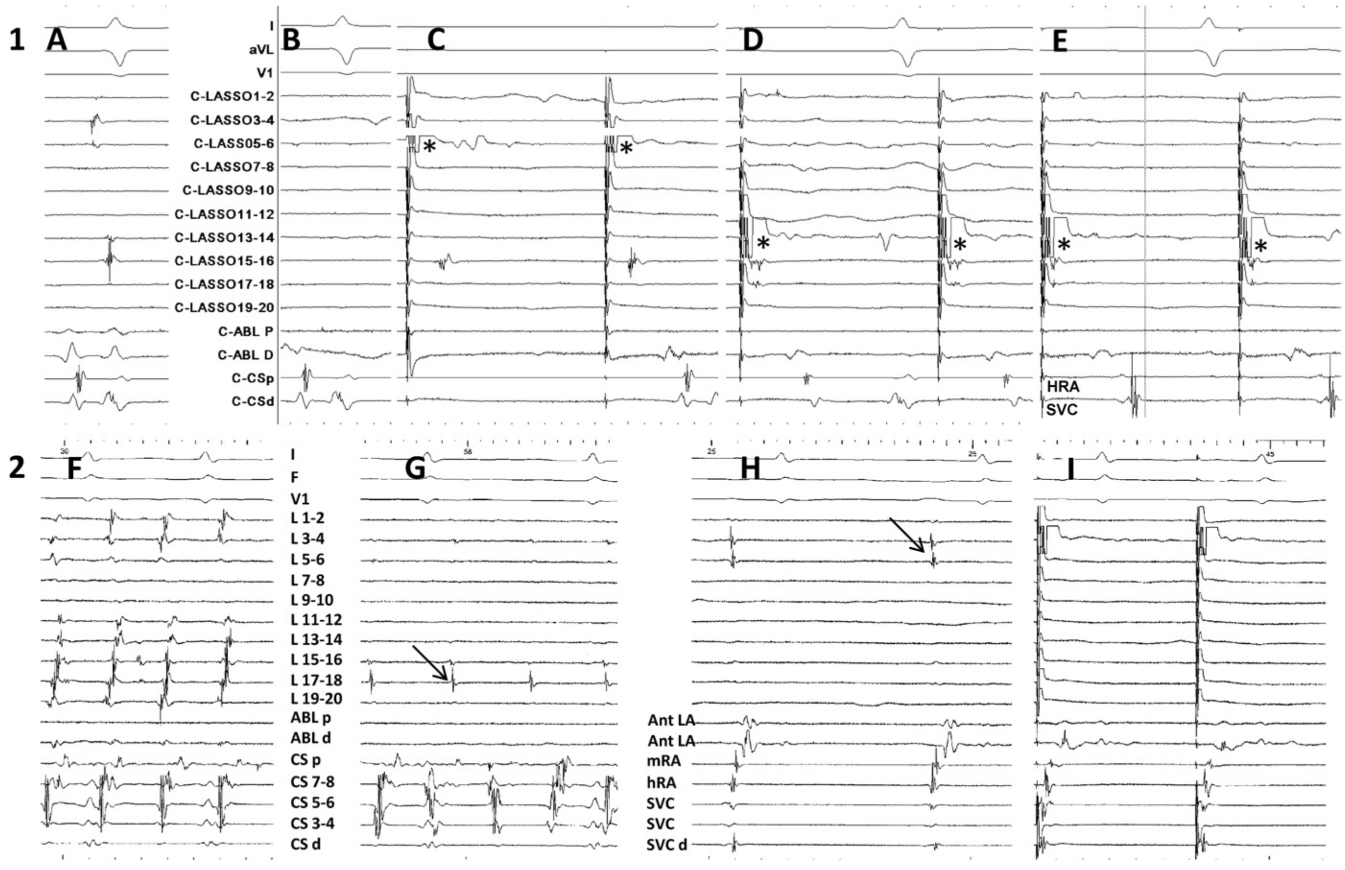

Figure 1 **Top panel:** Surface lead I, aVF, and V_1 and intracardiac electrograms are shown during sinus rhythm and various pacing maneuvers from the RSPV in a patient with a prior AF ablation procedure. **A:** Baseline electrograms in the RSPV show minimal PV reconnection with 2 separate fascicles. **B:** Postablation, no PV potentials are seen. **C:** Pacing from L5-6 (226) shows PV capture without conduction to LA. **D:** Pacing from L13-14 (226) shows PV capture with 1:1 PV-LA conduction. It is unclear whether this represents far-field capture or lack of exit block. **E:** Decapolar CS catheter is now moved to the SVC, which shows that RA-SVC activation is later than the LA activation recorded from the ablation catheter. This confirms PV-LA conduction and excludes far-field SVC-RA capture. **Bottom panel:** RSPV activation in a different patient with persistent AF. **F:** The RSPV shows rapid PV activity in AF. **G:** Following circumferential ablation, this vein still shows prominent sharp potentials in the anterior segment of the vein. **H:** Sharp high-frequency signals are again seen in this vein in sinus rhythm. Activation timing is simultaneous with SVC-RA electrograms and earlier than anterior LA, suggesting this to be far-field. **I:** All 10 Lasso bipoles did not show PV capture as evidenced by lack of local electrograms, despite pacing at 20 mA. However, there is 1:1 atrial capture with earliest activation at the SVC when paced from L3-4, confirming far-field SVC capture. ABL = ablation; ABL p=ablation proximal; ABL d = ablation distal; AF = atrial fibrillation; antLA = anterior left atrium; CS = coronary sinus; d = distal; ExB = exit block; HRA = high right atrium; L = Lasso; MRA= mid right atrium; p=proximal; PV = pulmonary vein; RSPV = right superior pulmonary vein; SVC = superior vena cava.