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SPOTLIGHT

Atrial flutter with an epicardial and endocardial breakthrough in the cavotricuspid isthmus

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A 75-year-old man underwent catheter ablation for atrial tachycardia (AT). The 12-lead electrocardiogram (ECG) showed sawtooth waves suggesting typical atrial flutter (AFL) (Figure 1). The intracardiac electrograms of the AT with a tachycardia cycle length (TCL) of 250 ms showed a proximal to distal activation pattern in the coronary sinus (CS) electrode catheter, and the decapolar catheter along the tricuspid annulus (TA) also had a proximal to distal activation. Entrainment mapping revealed that the cavotricuspid isthmus (CTI) was in the reentrant circuit (data not shown). Therefore, we diagnosed the AT as a CTI-dependent AFL and performed a CTI linear ablation (35 W power setting, interlesion distance within 4 mm, and target Lesion Size Index^{TM} of more than 4.5) with an open-irrigated contact force sensing catheter (TactiCath™ SE; Abbott) and three-dimensional electro-anatomical mapping system (EnSite NavX^{TM};

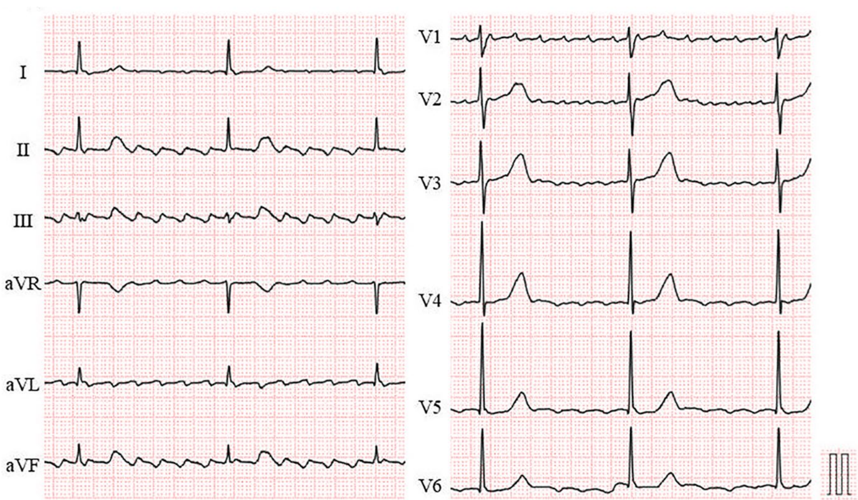

FIGURE 1 12-lead electrocardiogram on admission. This figure shows the 12-lead electrocardiogram before the catheter ablation with sawtooth waves in the inferior leads and an atrioventricular conduction of 6 to 1

Abbott). However, the AFL did not terminate, and even the TCL did not prolong at all after the first CTI linear ablation. Therefore, the activation mapping was performed using a high-density 16-electrode Advisor™ HD Grid catheter (Abbott), which demonstrated a wavefront moving around the TA and bridging across the CTI ablation line in a counterclockwise rotation. On the septal side of the CTI ablation line, the endocardial activation pattern exhibited the earliest activation site far from the CTI ablation line (site B in Figure 2, center). Postpacing intervals (PPIs) during the entrainment mapping at sites A and B were 248 and 249 ms, respectively, which matched the TCL (green dots in Figure 2, center). The activation map revealed that intrinsic conduction block had existed around site B (black dotted line in Figure 2, center), and the PPIs at sites C (358 ms) and D (326 ms) did not match with the TCL. The above electrophysiological findings suggested the existence of a bridging epicardial fiber (epicardial-endocardial breakthrough [EEB]), which crossed over the CTI area. Ablation at site B (Figure 2, center) terminated the AFL. However, the intracardiac electrograms recorded by a decapolar catheter during CS ostium pacing indicated that the CTI conduction block was incomplete. Therefore, another activation map, which was created during CS ostium pacing, showed that the activation wavefront traveling toward the CTI line disappeared at site B (green dot in Figure 3I) and reappeared from the lateral side of the CTI ablation line with a centrifugal pattern at site E. The unipolar electrogram at site E exhibited a tiny and dull R wave followed by a large S wave, suggesting that activation was from a deep layer, that is, the epicardium. The conduction time from site B to site E was 30 ms. On the other hand, the conduction times from sites C and D to site E were longer than that from site B (87 and 110 ms, respectively, Figure 3I). We performed a separate linear ablation to connect the two intrinsic block lines (black dotted line in Figure 3) despite another line in the lateral area (around site B), and bidirectional block of this circuit was successfully created (Figure 3II). A separate line ablation across site B appeared to eliminate the "entry" and "exit" conduction of the EEB.

In the present case, a CTI linear ablation was substantially performed; however, the TCL did not change at all. Repeated or broad linear ablation is usually performed in such cases. We performed high-density mapping with an HD Grid™ catheter after the first CTI linear ablation, revealing intrinsic block lines and the EEB. There was a possibility that the first attempt of the CTI linear ablation only ablated the endocardium, resulting in the epicardial myocardium possibly being spared; however, the activation breakout point on both sides of the CTI was quite far from the CTI ablation line. Recent research has reported that the EEB was found in 54% of patients with right atrial macro-reentrant tachycardia. Considering that the TCL was not affected by the first attempt of the CTI block line at all, we assessed whether the EEB was part of the circuit of this tachycardia. The highly versatile EnSite system with an HD-grid catheter

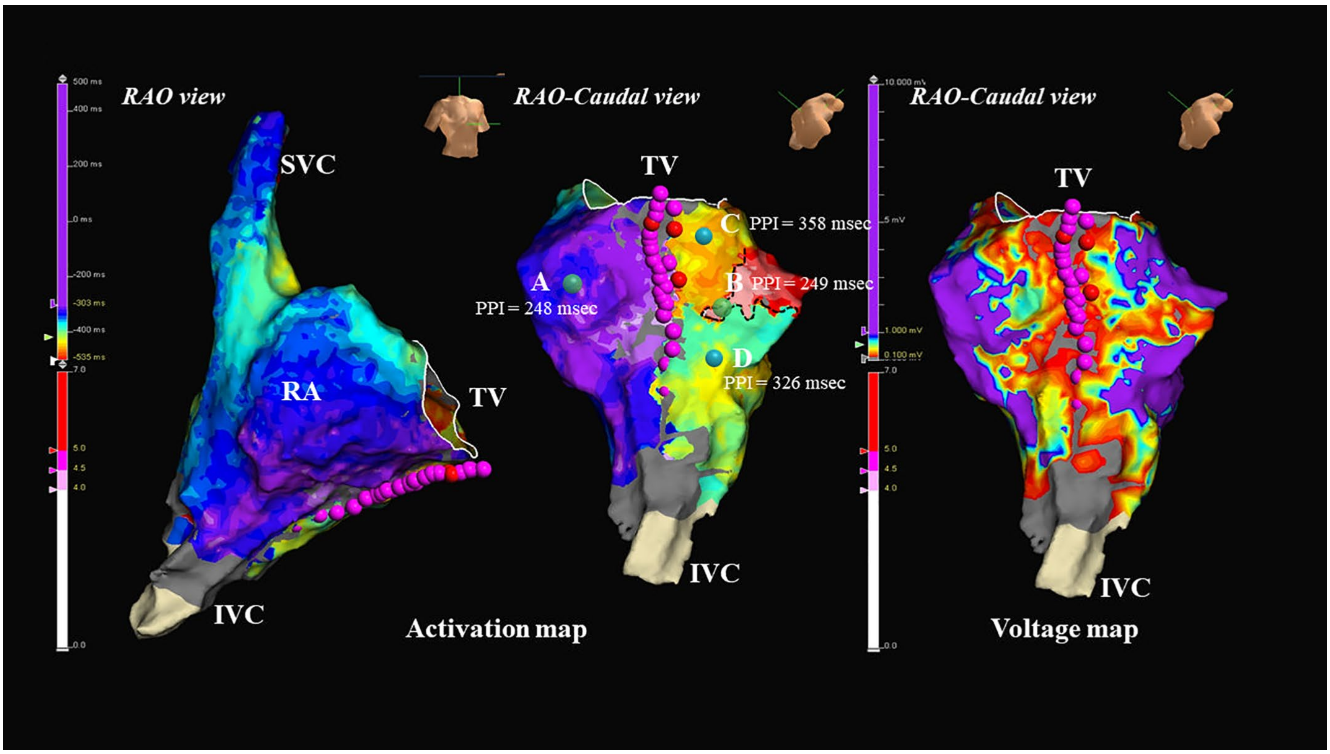

FIGURE 2 Activation and voltage maps during AFL after the CTI linear ablation. This figure shows activation maps (left and center panels) and a voltage map (right panel) of the right atrium after the first CTI linear ablation. The postpacing intervals were 248 (A), 249 (B), 358 (C), and 326 ms (D). The ablation tags indicate purple (LSI 4.5–5.0) or red (LSI >5.0) dots. The black dotted lines (center panel) represent intrinsic conduction block. CTI, cavotricuspid isthmus; IVC, inferior vena cava; RAO, right anterior oblique; SVC, superior vena cava; TV, tricuspid valve

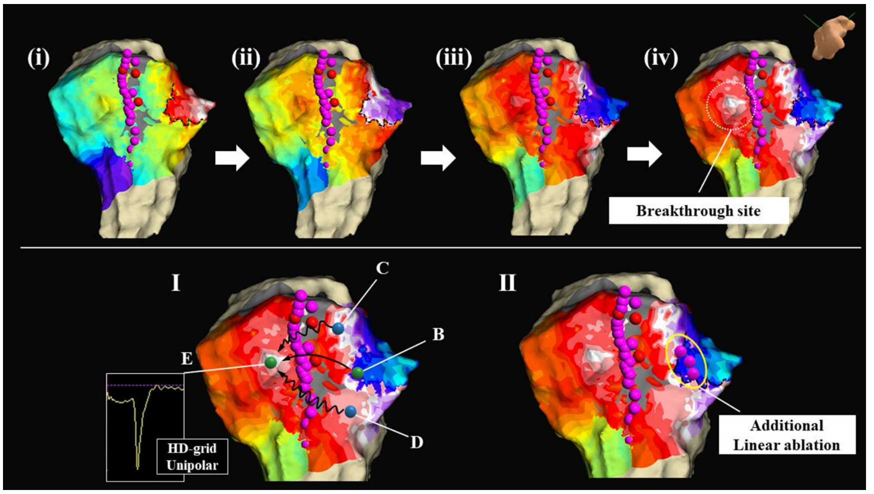

FIGURE 3 Activation maps during CS ostium pacing. The upper panels show still images of the activation map during CS ostium pacing, arranged in an order from (i) to (iv). The white areas indicate the activation wavefront. The wavefront was interrupted at the black dotted line and reappeared from site E with a centrifugal pattern. The unipolar electrogram recorded at site E exhibits a tiny and dull R wave followed by a large S wave, suggesting this activation was from a deeper layer, that is, the epicardium. (I) shows the conduction features from sites B, C, and D to site E. The actual conduction times were 30 (B–E), 87 (C–E), and 110 ms (D–E), respectively. (II) shows an additional ablation line represented as the yellow oval line. CS, coronary sinus

was helpful to assume the presence of an EEB. Furthermore, as in this case, identifying the EEB fiber attachment sites was crucial to successfully treating the tachycardia with an EEB.

CONFLICT OF INTEREST

Authors declare no conflict of interests for this article.

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