ARRHYTHMIA ROUNDS

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Atrial Tachycardia After Atrial Fibrillation Ablation: What Is the Mechanism?

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Case Presentation

A 58-year-old male was admitted for catheter ablation of recurrent atrial tachycardia (AT; Fig. 1A) following 4 previous paroxysmal atrial fibrillation (AF) ablation procedures at other centers involving pulmonary vein (PV) isolation and linear ablations, including cavotricuspid isthmus (CTI), left mitral isthmus, left atrial (LA) roof, and LA anterior line connecting mitral annulus with the roofline. Although the linear block across LA roof and CTI had been achieved, linear block across mitral isthmus and the anterior line had not been achieved. Baseline tachycardia cycle length (TCL) was 208 milliseconds. A steerable decapolar catheter was inserted into the coronary sinus (CS), and an externally irrigated ablation catheter was advanced into the LA via a transseptal puncture using radiofrequency (RF) energy. Activation mapping of LA was compatible with both the roof-dependent AT (the activation fronts are of opposing directions in the anterior and posterior LA) and perimitral AT. Entrainment maneuver showed that postpacing interval (PPI) minus TCL (PPI–TCL) was 0, 0, 10, 0, and 86 milliseconds at LA septum, LA anterior wall, LA low posterior wall, LA high posterior wall, and LA appendage (Fig.1B), respectively. What is the mechanism of this AT and what should be done next?

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Commentary

Over the last decade, catheter ablation of AF has become an important therapy with reasonably good procedural success rates. In parallel, macroreentrant left ATs post-AF ablation have been increasingly observed, especially after extensive LA substrate modification.[1,2] Activation mapping and entrainment mapping are useful techniques for the

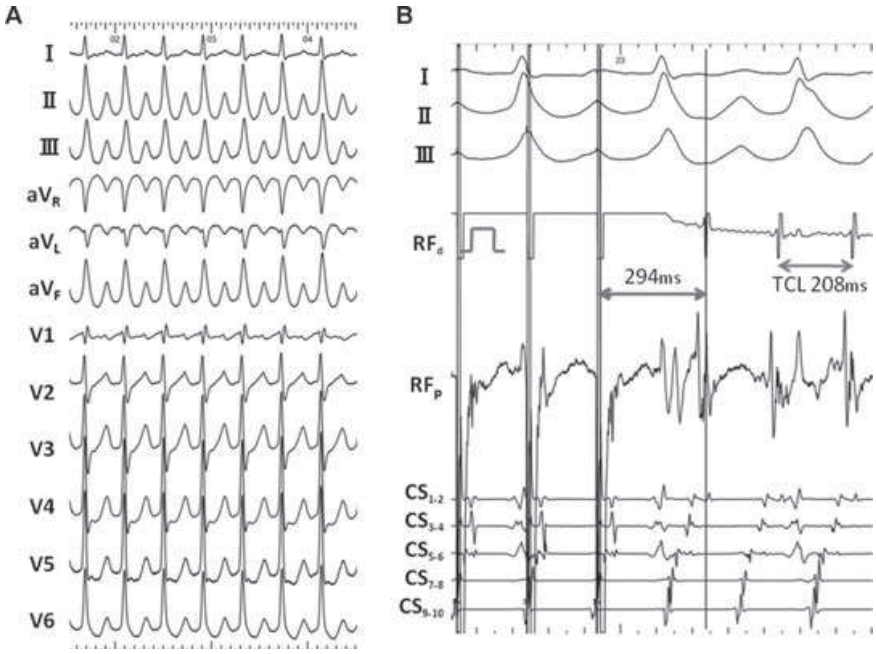

Figure 1. *A: A 12-lead electrocardiogram of clinical atrial tachycardia. B: Mapping catheter is positioned at the LA appendage. Postpacing interval minus tachycardia cycle length (PPI–TCL) was 86 milliseconds, which suggested that LA appendage was possibly lying far away from the tachycardia circuit. RF = mapping catheter; p = proximal; d = distal; CS = coronary sinus; LA = left atrium.*

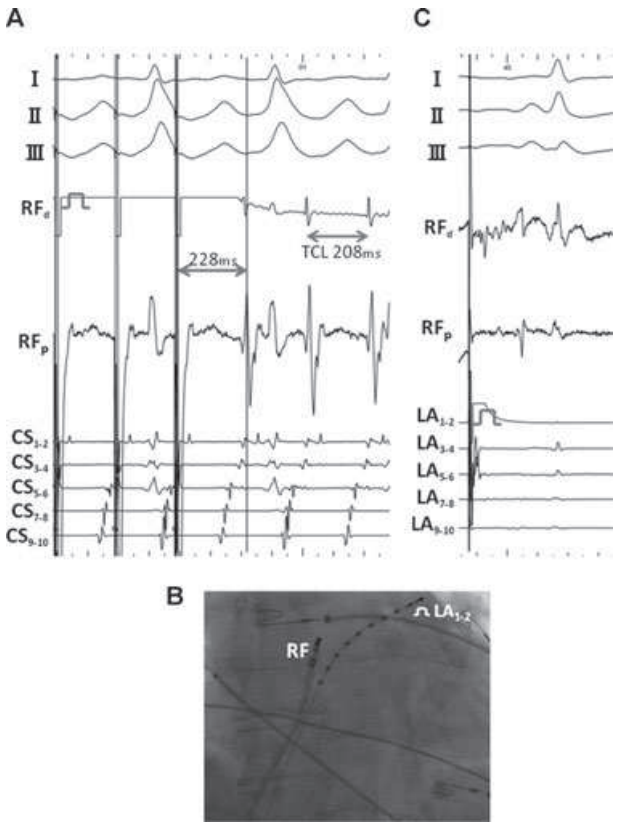

Figure 2. *A: Mapping catheter is positioned at the lateral left atrial (LA). Postpacing interval minus tachycardia cycle length (PPI–TCL) at lateral LA was 20 milliseconds, which suggested that lateral LA lies almost within the tachycardia circuit. B: Mapping catheter is positioned at the LA appendage. C: A gap potential on the anterior line was recorded close to LA roofline during pacing from LA appendage (B). Ablation application at this spot resulted in bidirectional conduction block across anterior LA line.*

diagnosis of these ATs, and both are essential to reach an exact diagnosis.[3-5] If the pacing site is in the reentrant circuit, a stimulus that falls during the excitable gap captures and resets the tachycardia during the entrainment pacing. The stimulated orthodromic wavefront resets the circuit and returns to the pacing site after completing 1 revolution around the circuit. Thus, the interval from the last stimulus to the subsequent depolarization recorded at the pacing site is equal to the revolution time around the circuit, which is equal to the TCL. However, there are some pitfalls of activation mapping and entrainment mapping techniques used for the diagnosis of ATs post-AF ablation.

The LA appendage is a favorable pacing site because it ensures stable tissue capture. Usually the PPI–TCL should be short at LA appendage, when the AT mechanism is perimitral AT or roof-dependent AT, rotating around left PVs; however, this case presented long PPI–TCL at LA appendage (Fig. 1B). Figure 2A showed 20 milliseconds of the PPI–TCL at lateral LA (Fig. 2A), which suggested that the lateral LA was almost in the tachycardia circuit. Because PPI–TCL at high posterior LA (close to roofline and far from mitral annulus) was 0 milliseconds and activation sequence was compatible with roof-dependent AT, we diagnosed dual-loop macroreentrant tachycardia (perimitral AT and roof-dependent AT). We started mitral isthmus and roofline ablation, which could not result in the termination of the AT. Because perimitral conduction delay measured following an electrical cardioversion was short, we took an alternative strategy of drawing a complete anterior LA line[6] that now had no risk of LA appendage electrical isolation. After the achievement of roofline block, mapping during LA appendage pacing revealed the conduction gap on the anterior line close to the LA roofline (Fig. 2B,C), which was closed by 1 RF application. Bidirectional conduction block across anterior line was confirmed by differential pacing technique[7]

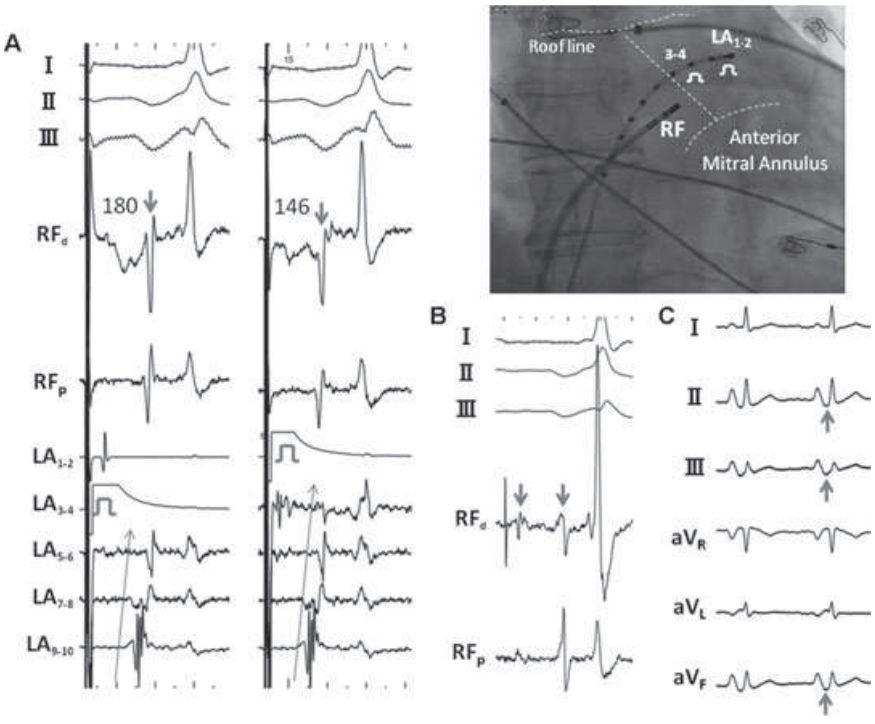

Figure 3. *Demonstration of bidirectional conduction block across anterior line joining mitral annulus and left atrial roofline. A: Radiofrequency (RF) catheter is positioned at septal side of the line. During pacing from LA 3-4, which is just lateral to the line, the delay from the pacing artifact to the atrial potential on the RF catheter is 180 milliseconds. Changing the pacing site to LA 1–2, which is more lateral to the line, results in a shorter delay on the catheter (146 milliseconds). Note that pacing from LA 1-2 and from LA 3-4 results in proximal-to-distal activation (blue arrow) on the decapolar catheter, which is positioned at anterior LA. B: The double potentials (red arrows) are observed along the anterior line during pacing from LA 3-4. C: After the achievement of anterior linear block, typical change of P-wave morphology, namely negative deflection of terminal P wave in inferior leads (red arrows) was observed.*

(Fig. 3A), and double potentials were recorded on the line in sinus rhythm (Fig. 3B). After the achievement of linear block, negative deflection of terminal *P* wave in inferior leads was observed[6] (Fig. 3C).

In this case, the incomplete anterior line caused conduction delay from the tachycardia circuit to the LA appendage-pacing site. The PPI does not depend on the anatomical distance, but on the conduction velocity from the pacing site to the tachycardia circuit. This case highlights the importance of considering the previous lesion set, especially previous linear lesion, when entrainment mapping is performed. Pacing site should be carefully selected considering the previous lesion set and the estimated tachycardia mechanisms.

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