Paradoxical delayed capture of the posterior wall in cavotricuspid isthmus-dependent atrial tachycardia: What is the mechanism?

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KEYWORDS

Atrial tachycardia; Cavotricuspid isthmus; Tricuspid annulus; Entrainment pacing; Dual loop

CASE PRESENTATION

A 37-year-old man was referred to our institution for ablation of a cavotricuspid isthmus (CTI)-dependent atrial tachycardia (AT). The AT was terminated by linear ablation to the CTI. However, the same AT recurred, and a second procedure was performed. A surface electrocardiogram showed flutter waves with a negative deflection in the inferior leads (Fig. 1A). To assess the detailed activation sequence of the AT, two 20-pole deflectable electrode catheters were placed in a parallel position on the tricuspid annulus (TA) and right atrial lateral wall (LW) (Fig. 1B–D). During AT (cycle length: 280 ms), counterclockwise activation was observed in both the catheters, and a gap with conduction delay was observed on the anterior part of the CTI block line (Fig. 2A). During entrainment pacing from the lateral TA, the LW was captured one cycle later than the TA (Fig. 2B). In contrast, during entrainment pacing from the proximal coronary sinus (CS), the TA and LW were captured simultaneously (Fig. 2C). AT was terminated during radiofrequency application to the gap on the CTI block line. After the termination of AT, the completion of the CTI block line was confirmed. AT did not recur after the procedure. What is the mechanism of the delayed capture of the LW during entrainment pacing from the lateral TA?

DISCUSSION

CTI-dependent AT has been considered a single-loop tachycardia on the TA.[1,2] However, previous studies[3,4]suggested that a portion of CTI-dependent ATs is a dual-loop tachycardia with an anterior circuit on the TA and a posterior circuit around the functional block line on the posterior wall. In the present case, the LW was captured later than the proximal CS during entrainment pacing from the lateral TA (Fig. 2B). This phenomenon is paradoxical for the single-loop mechanism because a site close to the pacing site was captured later than a site remote from the pacing site (paradoxical delayed capture). The dual-loop mechanism might explain this paradoxical delayed capture. During entrainment pacing from the lateral TA, pacing directly captured the anterior circuit on the TA, and then the activation propagated to the proximal CS through the CTI. Thereafter, the activation propagated to the posterior circuit and reached the LW (Fig. 3A).

Moreover, the anterior and posterior circuits should have a common isthmus. The TA and LW were captured simultaneously during entrainment pacing from the proximal CS (Fig. 2C). This finding suggests that the inferior septum around the proximal CS is the common isthmus, where pacing can capture both the anterior and posterior circuits (Fig. 3B). Moreover, the CTI should also be the common isthmus of the two circuits as the radiofrequency application in the gap on the CTI block line terminated the AT. Therefore, the mechanism of AT was a figure-8 dual-loop macroreentry with the common isthmus on the CTI and inferior septum.

It is noteworthy that the dual-loop mechanism in the present case cannot be revealed by activation mapping, as both circuits propagate in the same direction. Therefore, this case provides proof that conventional pacing maneuvers are still useful in this high-density mapping era.

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FIGURE

Figure 1

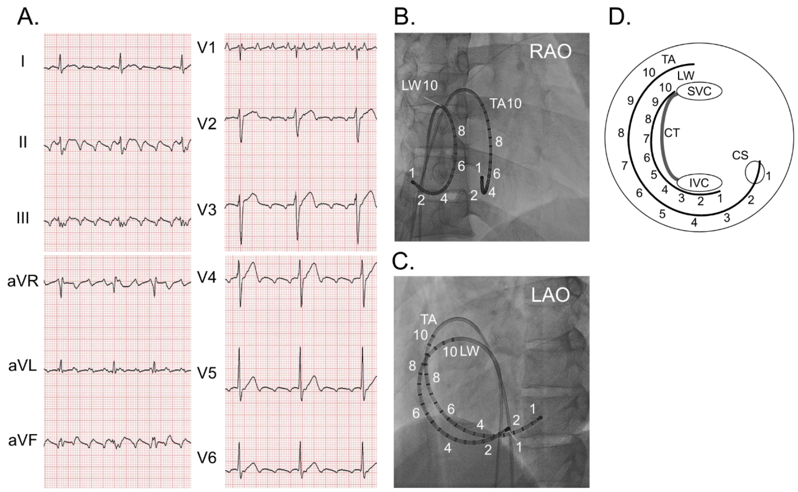

Figure 1. A: Surface electrocardiogram during atrial tachycardia. B, C: Catheter locations in right anterior oblique (RAO, B) and left anterior oblique (LAO, C) views. A 20-pole electrode catheter was placed on the tricuspid annulus (TA) with distal electrodes inside the coronary sinus, and another catheter was parallelly placed on the right atrial lateral wall (LW) close to the crista terminalis (CT). D: The schema of electrode locations. CS, coronary sinus; IVC, inferior vena cava; SVC, superior vena cava.

Figure 2

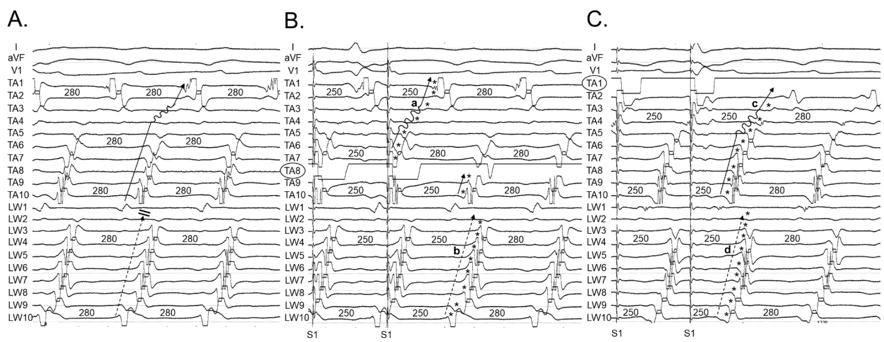

Figure 2 . Tracings show surface electrocardiograms in leads I, aVF, and V1, and electrograms of the tricuspid annulus (TA) and right atrial lateral wall (LW). A: During atrial tachycardia. Counterclockwise activation was observed in both the TA and LW. Activation was blocked in LW1, located on the posterior part of the cavotricuspid isthmus (CTI), and conduction delay was observed between TA4 and TA1, located on the anterior part of the CTI. B: During entrainment pacing from the lateral TA. The asterisks indicate the last captured beats, which returned with the pacing cycle length. The TA was captured directly by pacing (arrow a), whereas the LW was captured one cycle later than the TA (arrow b). Note that the LW was captured later than the proximal CS (TA1). C: During entrainment pacing from the proximal coronary sinus (TA1). The TA and LW were captured simultaneously by pacing (arrows c and d).

Figure 3

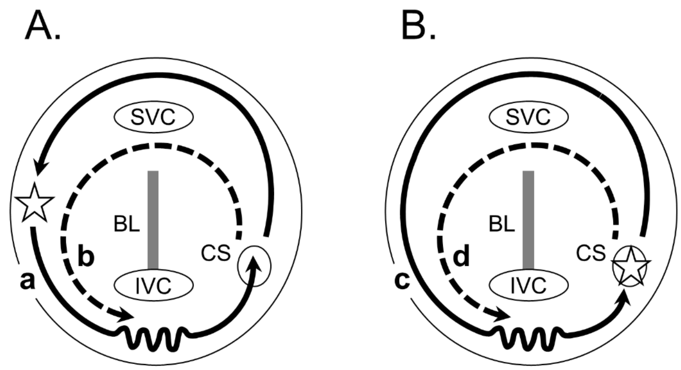

Figure 3. A: Activation during entrainment pacing from the lateral tricuspid annulus (TA). Pacing (star) directly captured the anterior circuit (arrow a) on the TA and the posterior circuit (arrow b) around the block line on the posterior wall later. B: Activation during entrainment pacing from the proximal coronary sinus (CS). Pacing captured the anterior circuit (arrow c) and posterior circuit (arrow d) simultaneously. The letters on the arrows correspond to those in Fig. 2. IVC, inferior vena cava; SVC, superior vena cava.