Alternating tachycardia cycle length occurring during catheter ablation of typical atrial flutter: What is the mechanism?

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1 | CASE

A 67-year-old man with a history of tachycardia-induced cardiomyopathy and atrial flutter (AFL) underwent electrophysiological testing. During the electrophysiological study, a decapolar catheter was positioned within the coronary sinus (CS) with the most proximal electrode pair at the CS ostium. At baseline, AFL persisted with a proximal to distal atrial activation sequence within the CS. Activation mapping and entrainment pacing from the cavotricuspid isthmus (CTI) diagnosed that AFL as a counter-clockwise (CCW) CTI-dependent AFL. Linear ablation was then performed at the CTI. During the ablation, the tachycardia cycle length (CL) prolonged, and also an alternating CL of the tachycardia was observed. During the tachycardia with an alternating CL, the ablation catheter was positioned at the lateral and middle portions of the CTI to record the local atrial activations (Figure 1). Thus, mechanism involved in alternating CL was discussed in this report.

2 | DISCUSSION

During the tachycardia, the atrial activation sequence was from the septal CTI to the CS ostium, and then to the lateral CTI (Figure 1). In addition, the change in the tachycardia CL within the CTI preceded that within the CS. These findings suggested that the CTI should have been the critical isthmus of AFL. In fact, additional radiofrequency ablation at the bottom of the pouch of the CTI terminated AFL.

Because the CTI was suggested to be the critical isthmus, the differential diagnosis of the tachycardia consisted of CCW CTI-dependent AFL with two loops around the inferior vena cava and tricuspid annulus and that with an alternating conduction time through the CTI. In the first and second mechanisms, the difference in the tachycardia CLs should have been attributed to the difference in the conduction times from the septum to lateral wall of the right atrium and that through the CTI, respectively. In this case, the conduction times travelling from the CS ostium to the lateral CTI were the same between the two different tachycardia CLs (Figure 1A). Therefore, the first mechanism was unlikely, and AFL was suggested to be CCW CTI-dependent AFL around the tricuspid annulus. In addition, a difference in the conduction times travelling from the lateral CTI to the CS ostium through the CTI preceded the change in the tachycardia CL (Figure 1A). These findings suggested that the second mechanism should have operated in this tachycardia.

What caused the alternating conduction time through the CTI (longitudinal dissociation)? Anatomically, there are pectinate muscles in the CTI, which exist as separated and electrically insulated muscle bands. Therefore, it was likely that the activation had conducted through the CTI alternatingly over the two different muscle bands with different conduction properties and refractory periods (fast and slow muscle bands; Figure 2). The ablation catheter was likely to have been positioned on the fast muscle band (FMB). After the activation had conducted through the FMB with a long refractory period, the next returning activation conducted through the slow muscle band (SMB) with a short refractory period while the FMB remained refractory. When the activation conducted through the FMB, the SMB might have been activated antegradely and retrogradely through the electrical connection between the FMB and SMB. However, when the activation returned to the lateral CTI, the SMB with a short refractory period should have recovered from the
refractoriness, allowing the activation to conduct through it. During the longer AFL-CL, the FMB could have recovered from the refractoriness, allowing the activation to conduct through it again.

When the AFL-CL became regular, the AFL-CL became approximately the same as the longer CL of the alternating CLs (Figure 1C). These findings suggested that the conduction through the FMB should have been terminated, and the activation should have conducted through the same SMB as when the AFL-CL alternated. In fact, the AFL-CL became slightly shorter than the longer CL of the alternating CLs. This finding suggested that the SMB should have been activated when the activation conducted through the FMB (Figure 2). When the AFL-CL alternated, the SMB should have
had a shorter period to recover from the refractoriness during the shorter AFL-CL after it was activated. On the other hand, when the AFL-CL became regular, the SMB should have had a longer period to recover from the refractoriness, resulting in a decrease in the decremental conduction property through the SMB. As a result, the activation could have conducted through the SMB slightly faster after the AFL-CL had become regular than when the AFL-CL alternated.

In the transition from an alternating to a regular AFL-CL, the CL and configuration of the local electrograms in the CTI continued to alternate (Figure 1C). This finding suggested that at that time the activation through the FMB should have reached the mapping catheter, but it had not gone through the CTI likely because it was blocked at the CTI ablation line.

CONFLICT OF INTEREST
The authors declare no conflict of interests for this article.

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