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Letter to the Editor

Fulfilling current criteria of bidirectional mitral isthmus linear block is necessary but not sufficient for prevention of recurrent peri-mitral atrial tachycardia☆

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Although mitral isthmus (MI) linear ablation [1] is challenging, it is required for perimitral atrial tachycardia (AT) frequently observed in the context of atrial fibrillation (AF) ablation [2,3]. Because incomplete block increases the risk of perimitral macroreentrant AT, the achievement of complete bidirectional conduction block is recommended as the end point of MI ablation according to the current guidelines. The completeness of bidirectional conduction block is evaluated by pacing maneuvers [4], which is a widely accepted gold standard method. We describe a case wherein perimitral AT was inducible reproducibly despite fulfilling the current criteria of bidirectional MI linear block.

A 49-year-old man was admitted for catheter ablation of recurrent AT under amiodarone administration following 3 previous longstanding persistent AF ablation procedures involving pulmonary vein (PV) isolation and ablation targeting complex fractionated atrial electrograms. At the 3rd procedure, recurrent perimitral AT was terminated by MI linear ablation. Then, bidirectional conduction block along the line was created using an externally irrigated ablation catheter (Thermocool, Biosense-Webster). However, persistent AT recurred 2 days after the 3rd procedure. The patient underwent 4th procedure 6 months after the 3rd procedure. Baseline AT cycle length was 310 ms (Fig. 1A, B: green arrow). Activation sequence on 3-D mapping system (CARTO3, Biosense-Webster) was compatible with clockwise perimitral AT, however only 55% of AT cycle length (170 ms) was covered around the mitral annulus (Fig. 1C). Further mapping revealed a fractionated low-amplitude potential which accounted for the rest of 45% of AT cycle length (Fig. 1B: red arrow) on the MI line (Fig. 1C, D, white arrows). Entrainment mapping at both MI line and LA septum showed that post pacing interval equaled to AT cycle length. After 17 s of radiofrequency (RF) application at the site of fractionated low-amplitude potential, the AT terminated. Following the termination, we confirmed bidirectional conduction block using pacing techniques (Fig. 2A, B, C).

However, second AT was easily induced by burst pacing from coronary sinus (CS) immediately after confirming the block. Activation and entrainment mapping again showed that it was a perimitral AT. Another 15 s of point RF application on MI line terminated the second AT and bidirectional MI block was subsequently confirmed. However, third AT was induced by burst pacing from CS, which was diagnosed as perimitral AT. Another 25 s of point RF application on MI line terminated the third AT, and again bidirectional MI block was confirmed. However, fourth AT was induced by burst pacing from CS, which was diagnosed as perimitral AT. After 12 s of point RF application AT terminated and again bidirectional MI block was confirmed. However, the fifth AT was induced by burst pacing from CS, which was diagnosed as perimitral AT. Because endocardial RF applications could not result in non-inducibility of perimitral AT despite terminating perimitral AT repeatedly, we mapped inside the CS during AT. Although any gap potential was not identified inside CS, we applied a RF application at the site which was closest to the endocardial MI line anatomically (Fig. 2D, white arrows, E, white dots). After 15 s of RF application AT terminated (Fig. 2F). Again bidirectional MI block was confirmed by pacing techniques. Any AT/AF was not inducible by programmed stimulation after the application, and there has been no recurrence of atrial tachyarrhythmia until the last available follow-up (12 months). The measured anatomical distance between the final ablation site inside CS and endocardial MI line was 5.2 mm on a 3-D mapping system.

Establishment of transmural MI lesion is necessary to prevent recurrent perimitral AT although it may be challenging due to the tissue

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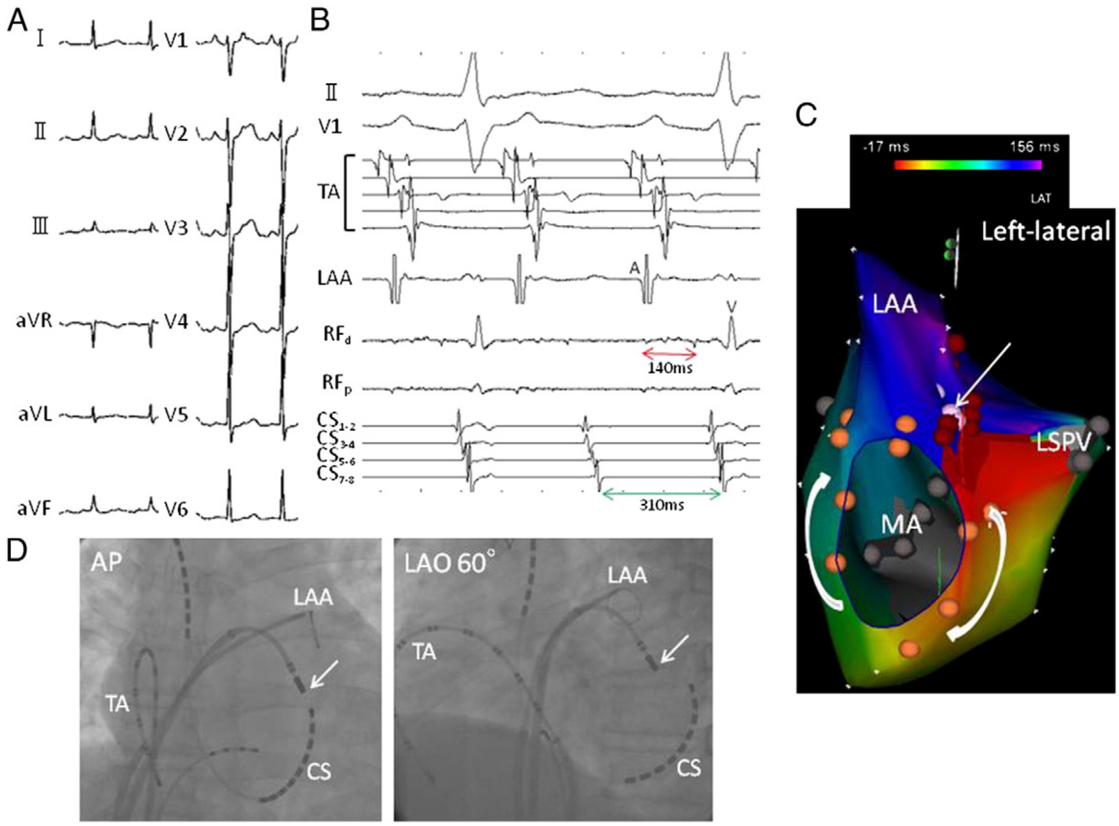

Fig. 1. A 12-lead electrocardiogram of clinical AT is shown (A). Tachycardia cycle length was 310 ms (B: green arrow). Activation sequence of the AT was compatible with clockwise perimitral AT on 3-D mapping system, however only 55% of the tachycardia CL (170 ms) was covered around mitral annulus (C). Further mapping revealed a fractionated low-voltage signal (0.05 mV) with a long duration (140 ms) (B: red arrow) on the MI line (C, D: white arrows). Therefore, the whole tachycardia cycle length was covered around mitral annulus. A point application at the site terminated the clinical AT. RF; mapping catheter, CS; coronary sinus, TA; tricuspid annulus, LAA; left atrial appendage, LSPV; left superior pulmonary vein, MA; mitral annulus, AP: antero-posterior view, LAO; left oblique view, d; distal, p; proximal, A; atrial potential, V; ventricular potential.

thickness and the complex anatomy [1]. In about 70% of the patients undergoing MI linear ablation, ablation from inside the CS is required to attain transmurality [1]. The method of assessing complete conduction block across the MI line involves mapping of the endocardial and the epicardial activation around the mitral annulus during pacing from two sites across the line. As described in the original article [1], pacing on one side of the line and simultaneous recording of the electrograms on the other were undertaken as close as possible to the line of block. Electrical block was differentiated from slow conduction by differential CS pacing [4]. Pacing distal bipoles on the CS catheter resulted in electrogram recording across the line of MI linear ablation later than that during more proximal bipole pacing on the CS catheter. Later, pacing from across the line of MI ablation resulted in proximal to distal activation of the CS. Widely separated, equidistant, local double potentials along the length of the linear ablation were often observed on both endocardium and epicardium. This is another widely accepted technique to identify bidirectional linear block.

Differential pacing technique [4] is widely used for the assessment of bidirectional conduction block across the linear lesion. However, as the original paper [4] pointed out its limitation, very slow conduction through the isthmus may not be absolutely ruled out by this technique. In this case, bidirectional MI linear block was created and confirmed at the third procedure. Because the current criteria of bidirectional block was fulfilled and the clinical perimitral AT was eliminated by one RF application, subsequent induction test was not performed at the time. Nevertheless, AT recurred a few days later, therefore we set the end point of the 4th procedure as non-inducibility of AT. The clinical AT was again terminated by RF application on the MI line and bidirectional block was confirmed according to the current criteria. However, surprisingly perimitral AT was easily induced immediately after the confirmation of linear block. The perimitral AT was induced totally for 4 times following the confirmation of bidirectional block until the last RF application inside the CS opposite to the endocardial MI line terminated the AT and rendered it non-inducible. A previous paper has shown that residual epicardial connection between the left atrium and distal CS can play a critical role in bypassing the endocardially blocked MI line and perpetuate perimitral AT [5,6]. Although any gap potential was not recorded either epicardially or endocardially during perimitral AT in this case, it is most likely that very slow conduction contributed to the inducibility of perimitral AT. The gap must have remained in the deeper layers of the local tissue, considering the fact that AT was not inducible after single RF application inside the CS and has not recurred until the last available follow-up till date.

Although there are several pitfalls in the assessment of bidirectional MI linear block [7], all the necessary precautions were taken in the assessment of block in this case. This case highlights the limitation of current criteria of "true" bidirectional MI block: differential pacing maneuvers, observation of split local signals, and measurement of perimitral conduction delay [8]. It is possible that classical criteria overestimate the incidence of "true" complete bidirectional conduction block across the MI line. This case suggests that additional induction test may be helpful to distinguish very slow conduction from "true"