

## EP CASE REPORT

# Elaborating endocardial mapping the Marshall bundle revealed a perimitral flutter mediated by ligament of Marshall

Songwen Chen \*, Xiaofeng Lu, and Shaowen Liu\*

Department of Cardiology, Shanghai General Hospital, Shanghai Jiao Tong University, School of Medicine, No 100, Haining Road, Shanghai 200080, China

\* Corresponding author. Tel: +86-18017638339; fax: +86-21-63249416. E-mail address: chensongwen@hotmail.com; Tel: +86-15301655536. E-mail address: shaowen.liu@hotmail.com

A 66-year-old man was referred for catheter ablation in the treatment of persistent atrial flutter, 60 months after his third ablation for long-standing atrial fibrillation. Echocardiogram showed a dilated left atrium (LA, 46 mm).

During procedure, spontaneous atrial flutter with irregular cycle length was encountered. Fragmental potentials were found in the ostium of the right pulmonary vein and were eliminated by reinforcement ablation. Roofline and modified posterior line ablation, which was performed to modify the substrate of posterior wall, converted the flutter to a regular cycle length of 240 ms. Bi-atrial activation mapping failed to identify the mechanism of the flutter due to a missing activation zone of 77 ms (32.1%, *Figure 1A*). However, potential of the ligament of Marshall (LOM) was recorded by elaborating endocardial mapping around the left lateral ridge (MP3 of *Figure 1B*). Counter-clockwise perimitral flutter (PMF) mediated by LOM, or ridge-related reentry (RRR) was then confirmed by activation mapping and entrainment ([Supplementary material online, Figure S1A, B](#)). Radiofrequency ablation at the LOM-LA connection terminated the flutter at 5.8 s and block the mitral isthmus (MI, [Supplementary material online, Figure S1A, C](#)). Differential pacing from the left atrial appendage, coronary sinus (CS), and LOM confirmed the conduction between the CS and LOM but with bidirectional conduction block of the MI ([Supplementary material online, Figure S2](#)). CS angiography failed to reveal a distinct vein of Marshall. Endocardial ablation, targeted at the LOM-CS connection, was performed to isolate the LOM successfully. After 30-min observation time for checking the bidirectional conduction block of ablation lines and no atrial arrhythmia could be induced, the procedure was terminated successfully. During the 12 months of follow-up, he was free of arrhythmias with metoprolol (50 mg).

Ligament of Marshall, an epicardia structure, is challenging and important for MI ablation.<sup>1</sup> Failed to ablation LOM may lead to the failure of MI block. Moreover, LOM was the frequent cause of complex PMF, including RRR. Generally, for recording potential of LOM, catheter should be placed via the vein of Marshall or by an epicardial approach. In this case, we recorded the potential of LOM from endocardial fortunately, and confirmed the PMF or RRR without the need of epicardial approach or LOM cannulation. Moreover, we found that not slow conduction across the ridge, but the normal conduction across the LOM resulted the PMF or RRR. Furthermore, endocardial ablation, targeted at the LOM-LA connection and LOM-CS connection, could isolate the LOM successfully. In conclusion, elaborating endocardial mapping and ablation of LOM or ridge are important for the reorganization and treatment of complex PMF.

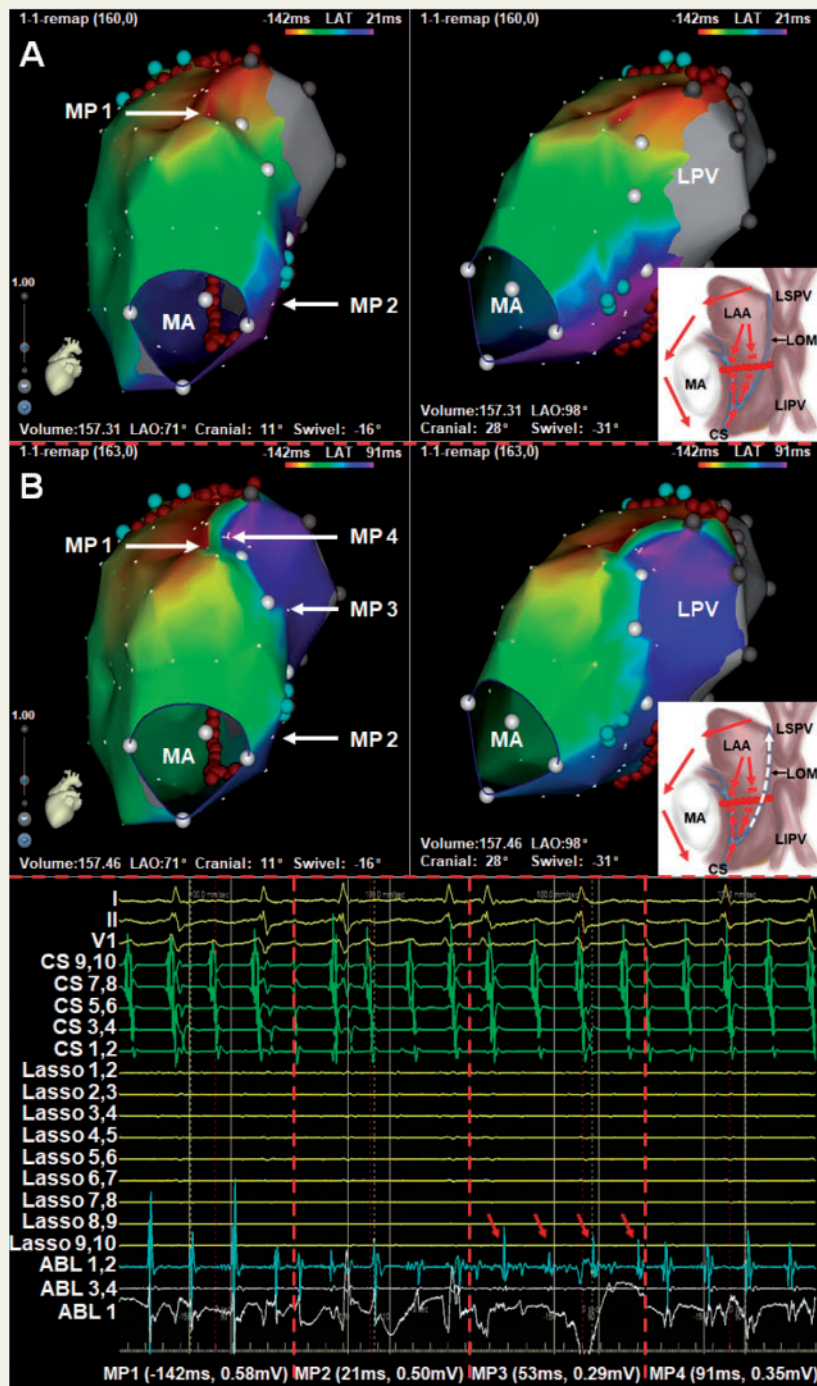
## Supplementary material

[Supplementary material](#) is available at *Europace* online.

**Conflict of interest:** none declared.

## Reference

1. Chen S, Zhou G, Lu X, Wei Y, Xu J, Cai L *et al*. The importance of identifying conduction breakthrough sites across the mitral isthmus by elaborate mapping for mitral isthmus linear ablation. *Europace* 2019;**21**:950–60.



**Figure 1** (A) The activation of left atrium (LA) was a centrifugal pattern with a total activation time of 163 ms. MP1 (in the roof) and MP2 [around the mitral isthmus (MI)] were the earliest and latest activation of the LA, respectively. The white dots indicated the ridge between the left atrial appendage (LAA) and left pulmonary vein (LPV). (B) While mapping at the ridge (MP3 and MP4), potential of the ligament of Marshall (LOM) was recorded and reveal that the perimitral flutter was mediated by LOM. The activation of LA and LOM was a reentry pattern with a total activation time of 233 ms. MP3 indicated that LOM potentials (red arrows), with the activation time of 53 ms relative to the reference line, was accompanied with far-field potentials of LAA. The activation time of the LOM-LA connection (MP4) was 91 ms relative to the reference line. In the schematic diagram, the red dots indicate the MI line (prior ablation), the red line indicates the activation direction, and the white dotted line indicates the conduction from the LOM and across the MI line. Lasso was placed in LSPV. CS, coronary sinus; LIPV, left inferior pulmonary vein; LSPV, left superior pulmonary vein; MA, mitral annulus; MP, mapping point.