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SPOTLIGHT

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Efficacy of functional substrate mapping to identify critical isthmus of atrial tachycardia

Yasuyuki Egami MD | Masami Nishino MD, PhD | Masamichi Yano MD, PhD | Yasuharu Matsunaga-Lee MD | Jun Tanouchi MD, PhD

Division of Cardiology, Osaka Rosai Hospital, Osaka, Japan

Correspondence
Masami Nishino, Division of Cardiology, Osaka Rosai Hospital, 1179-3, Nagasone-cho, Sakai-city, Japan.
Email: 3522mn@gmail.com

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Left atrial tachycardia (AT) is often observed in patients who have undergone atrial fibrillation (AF) ablation.[1] The main mechanisms of the ATs are macroreentry, such as peri-mitral flutter and roof-dependent AT.[2] The use of ultra-high-density mapping with multielectrode catheters enables to delineate the ATs rapidly and precisely.[3] However, due to the scar and low-voltage area (LVA), it can often be difficult to identify the circuit of AT exactly.

A 74-year-old woman with hypertrophic cardiomyopathy was referred to our institution for catheter ablation of symptomatic drug-refractory persistent AF. After a pulmonary vein isolation, high-density 3D electroanatomical mapping of the left atrium (LA) was performed using a 1-mm spacing multielectrode mapping catheter (PentaRay) and CARTO3® system. The voltage map during right atrial pacing (pacing cycle length: 600 ms) revealed an extensive LVA throughout the left atrium, especially in the septum (LVA: <0.5 mV in Figure 1(A) and LVA: <0.3 mV in Figure 1(B)). Thereafter, an AT [tachycardia cycle length (TCL):246 ms] was induced by right atrial burst pacing (Figure 2). The local activation time (LAT) map during the AT displayed a macroreentrant tachycardia rotating in the LA septum, but LA activation map covered <90% of the TCL (Figure 3(A), supplemental movies 1, 2). Postpacing interval (PPI) at the LA septum near mitral valve was equal to the TCL with orthodromic capture of all atrial potentials (Figure 3(B)), while PPI at the right atrium and proximal coronary sinus was greater than TCL by +266 ms and +132 ms, respectively. Therefore, the tachycardia was diagnosed as a macroreentrant tachycardia of the LA septum. However, many local potentials

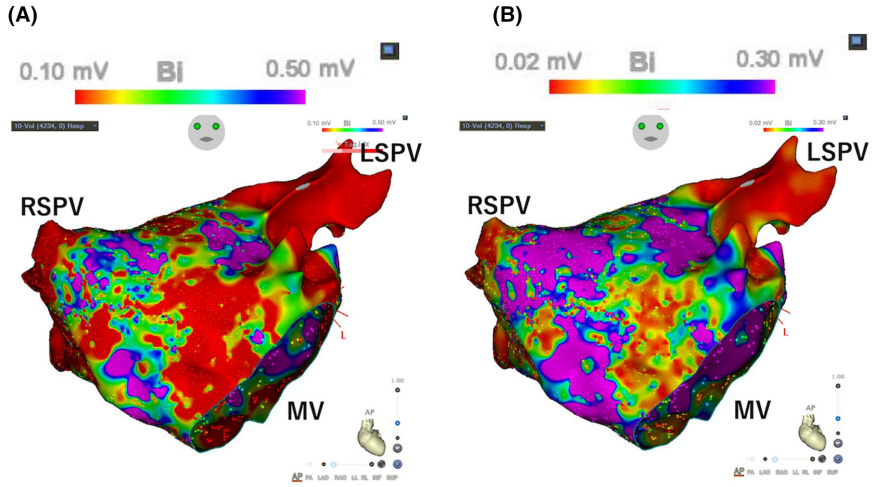

FIGURE 1 A voltage map during atrial pacing (600 ms) obtained using a 1-mm spaced multielectrode catheter (PentaRay®, Biosense Webster) with voltage criteria of 0.1–0.5 mV (A) and 0.02–0.3 mV (B). LAA—left atrial appendage; LAT—local activation time; LSPV—left superior pulmonary vein; MV—mitral valve; RSPV—right superior pulmonary vein.

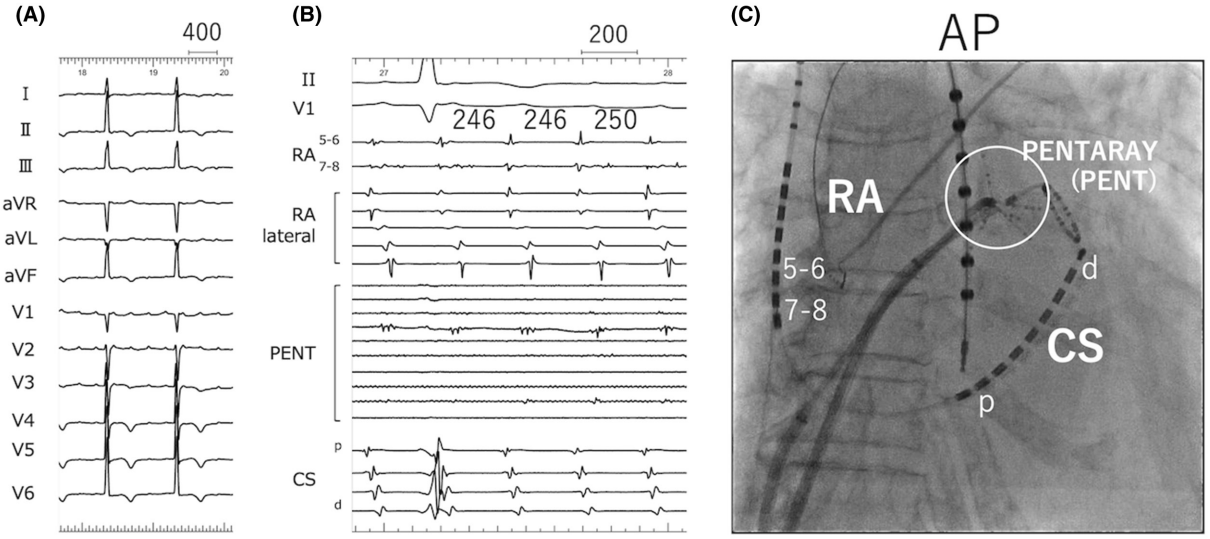

FIGURE 2 (A) Twelve-lead ECG (B) Intracardiac recording during atrial tachycardia (C) Fluoroscopic images of the ablation procedure. A 10-pole electrode was placed on the RA lateral wall, but the electrode catheter was not visible on the fluoroscopic image. CS—coronary sinus; d—distal; p—proximal; PENT—PentaRay mapping catheter; RA—right atrium.

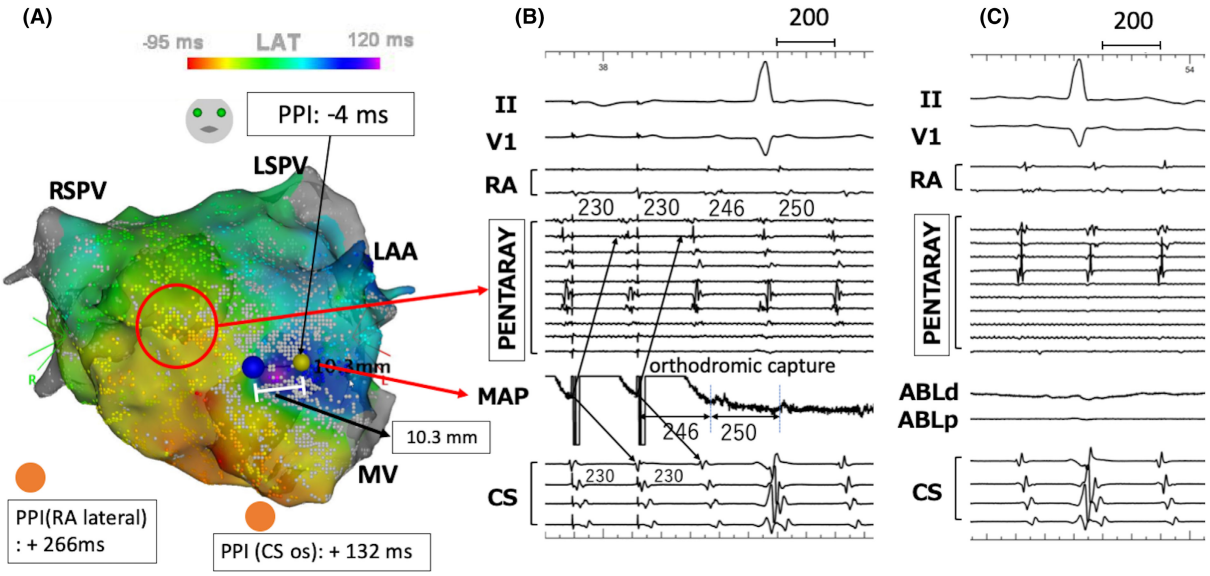

FIGURE 3 (A) LAT map during atrial tachycardia. Blue solid circle indicates successful ablation site. Yellow solid circle indicates site where the PPI was approximately equal to the tachycardia cycle length. The distance between the blue and yellow tags was 10.3 mm. Gray point indicates no annotated point. (B) Intracardiac recording during PPI study at LA septum. Pentaray catheter was placed on the LA septum. The pacing at the yellow tag site orthodromically captured all atrial potentials. (C) Intracardiac recording of successful ablation site. ABL—ablation catheter; EEML—extended early meets late; LA—left atrium; LAT—local activation time; MAP—mapping catheter; PPI—postpacing interval. The other abbreviations are shown in Figures 1 and 2.

of LA septum were too tiny to be annotated on the map (Figure 3(A)). Recently, Aziz Z et al.[4] demonstrated that slow conduction zones displayed by functional substrate mapping during sinus rhythm correspond to the critical isthmus of ventricular tachycardias. Based on the isochronal map during atrial pacing of 600 ms (Figure 4(A)), a radiofrequency application at the isochronal crowding site on the LA septum immediately terminated the AT.

Although entrainment mapping is an effective method to understand the mechanism of the target AT, it has the potential to terminate the AT. Zhang X et al reported that AT ablation with 3-D electroanatomical mapping alone has similar outcomes compared with 3-D electroanatomical mapping combined with entrainment mapping.[5] If the mechanism of AT circuit is fully understood by 3D electroanatomical mapping alone, entrainment mapping, which can

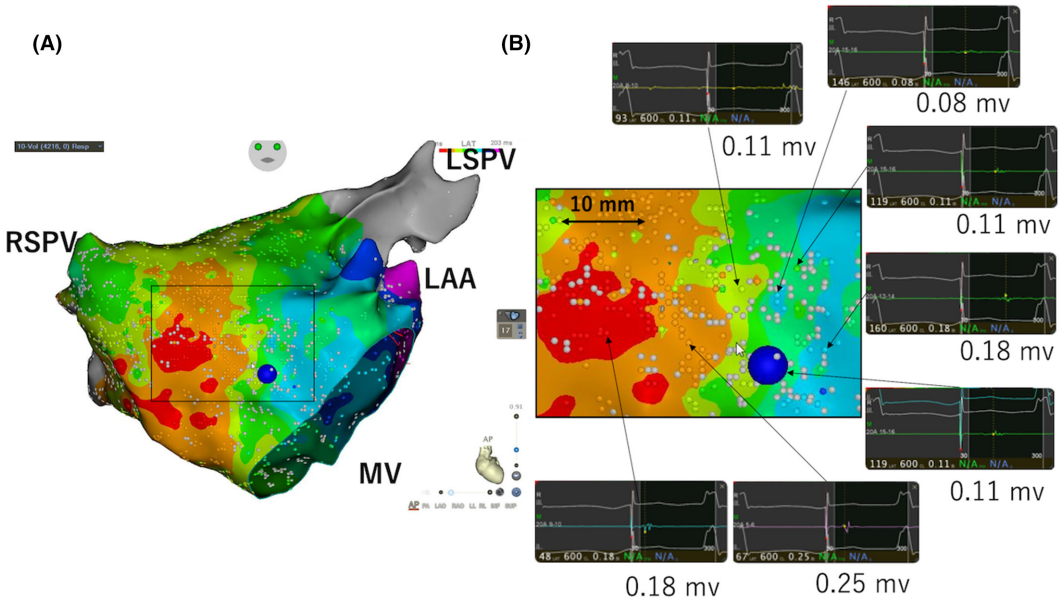

FIGURE 4 (A) Blue solid circle indicates the termination site of the tachycardia by radiofrequency application and the voltage of the site was 0.11 mV. (B) Magnified image of open black square on the figure 4(A). The black arrows indicated the local potential and voltage of each isochrone. The voltage of points of LA septum was very low, but most points were annotated on the map. Isochronal map was displayed with 8 equally distributed isochrones of the activation (100%/8 = 12.5% of the atrial activation comprised each isochrone). The abbreviations are shown in Figure 1.

terminate AT, would not necessarily be necessary. In mapping ventricular tachycardia, an approach that targets the deceleration zone during sinus rhythm has been shown to be effective in predicting critical isthmus.[4] Recently, a functional substrate mapping during sinus rhythm to identify the conduction slowing zone was shown to be useful to identify critical isthmus also in AT cases.[6,7] The automatic annotation of LAT using the Wavefront with CARTO3® system map often fails to accurately annotate local potentials within a broad LVA during AT. However, LAT map at pacing rate lower than heart rate during AT allows for relatively more local potentials to be annotated on the 3D map (Figure 4(B)). Therefore, in AT cases whose LAT maps are difficult to interpret, isochronal map at a pacing rate lower than the heart rate during AT may provide useful information to identify the termination site of AT.

FUNDING INFORMATION

None.

CONFLICT OF INTEREST DISCLOSURE

N/A

ETHICS APPROVAL STATEMENT

Approval was obtained from the local ethics committee.

PATIENT CONSENT STATEMENT

The patient provided written informed consent.

CLINICAL TRIAL REGISTRATION

N/A

ORCID

Yasuyuki Egami https://orcid.org/0000-0001-9728-6524
Masami Nishino https://orcid.org/0000-0003-0309-7023
Yasuharu Matsunaga-Lee https://orcid.org/0000-0002-4775-8914

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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