Case Report

Noncontact Mapping-Guided Catheter Ablation of Posterosuperior Right Atrial Tachycardia Associated with Sick Sinus Syndrome

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Focal atrial tachycardia (AT) is sometimes associated with sick sinus syndrome. A 57-year-old female complained of palpitation, fatigue and presyncope. Ambulatory monitoring demonstrated frequent segments of AT and subsequent sinus arrests. P wave morphology of ectopic beats was similar to that of sinus rhythm. After obtaining diagnosis of bradycardia tachycardia syndrome, she underwent electrophysiologic study (EPS) and radiofrequency (RF) catheter ablation to eliminate AT.

Conventional EPS could not be performed due to frequent spontaneous ectopic beats. EnSite mapping demonstrated that AT originates from posterosuperior right atrium (RA) and that local electrogram of ectopic focus precedes the onset of P wave in surface ECG by 40 msec. After EnSite-guided RF ablation to the target area, ambulatory monitoring detected no AT or sinus arrest. EPS performed one week after RF ablation showed atropine-induced partial restoration of sinus node dysfunction.

Her symptoms were resolved remarkably and permanent pacemaker implantation has not been necessary to date. RF ablation guided by EnSite mapping was useful to eliminate AT arising from limited ectopic focus and this case implies existence of "pacemaker-avoidable" bradycardia tachycardia syndrome.
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Key words: Atrial tachycardia, Noncontact mapping, Radiofrequency ablation, Sick sinus syndrome

Introduction

Focal atrial tachycardia (AT) is sometimes associated with sick sinus syndrome (SSS). Atrial muscle in SSS is reported to show diffuse fibrotic or fatty degeneration, which is assumed to be arrhythmogenic.[1] AT is usually refractory to antiarrhythmic drugs,[2] which suppress sinus node function that is already depressed by rapid electrical activity of AT (i.e., overdrive suppression). Moreover, it is often difficult to apply radiofrequency (RF) current to the limited area of ectopic focus in AT.

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Currently, electroanatomical, high resolution mapping such as CARTO and EnSite systems are useful in the field of electrophysiologic study (EPS). Because only limited information is available concerning EnSite mapping system application to AT ablation, we report a case of AT arising from the posterosuperior right atrium (RA) that was ablated successfully under the guidance of this sophisticated mapping system. This patient's AT was associated with SSS, but permanent pacemaker implantation has not been necessary to date after the successful RF ablation of the AT.

Case Report

A 57-year-old female was referred to our hospital due to palpitation, fatigue and presyncope. Standard ECG demonstrated frequent or repetitive atrial premature contractions (APCs) with P wave morphology similar to that of sinus beats. Strictly, P wave of APCs was greater in amplitude than that of sinus beats, i.e., ectopic P wave was negative in aV_L, sharp and positive in II, III, aV_F and biphasic in V_1 (**Figure 1A**), suggesting that the focus of APCs was in the high posterior RA.[3] Transthoracic echocardiography suggested no organic heart diseases. Ambulatory monitoring at CM_5-lead demonstrated frequent (314 times/day) segments of AT and subsequent sinus arrests (**Figure 1B**) with a maximum R-R interval of 8.2 sec. Waxing and waning of ectopic P wave rate were observed during AT. We obtained the diagnosis of bradycardia tachycardia syndrome. Oral flecainide (100 mg/day) suppressed AT but showed a limited effectiveness, i.e., ambulatory ECG showed no AT but frequent APCs (9970 beats/day) and sinus arrests (236 times/day) under the medication. Therefore, medication was terminated after admission. After obtaining written informed consent, this patient underwent EPS and RF ablation to eliminate the AT.

In the EPS laboratory, sinus node function test and pace-mapping were impossible because of frequent spontaneous APCs. Because ectopic foci of APCs were expected to be in the vicinity of compact sinus node, we applied the EnSite system (EnSite 3000 with Precision Software, Endocardial Solutions, Inc, St Paul, MN, USA). The EnSite system reconstructs virtual electrograms and three-dimensional cardiac chamber geometry by single beat analysis. This system consists of a workstation (Silicon Graphics, Mountain View, CA, USA) and a 64-electrode array noncontact balloon (7.5 ml) mounted on a 9Fr catheter which is inserted from the femoral vein into the RA. Color-coded isopotential mapping of

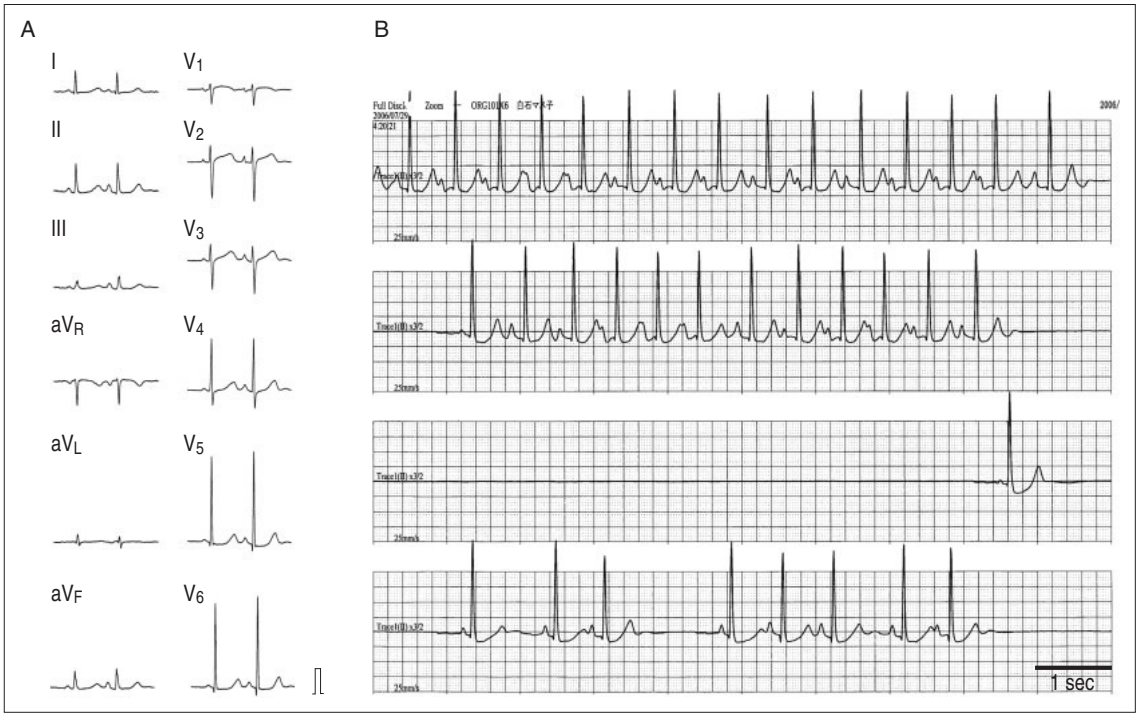

Figure 1 Standard (**A**) and ambulatory (**B**) ECG recorded after admission.
Standard ECG indicates sinus beat followed by atrial premature contraction (APC) with P wave morphology similar to that of sinus beat. Ambulatory monitoring demonstrates short segment of atrial tachycardia followed by sinus arrest.

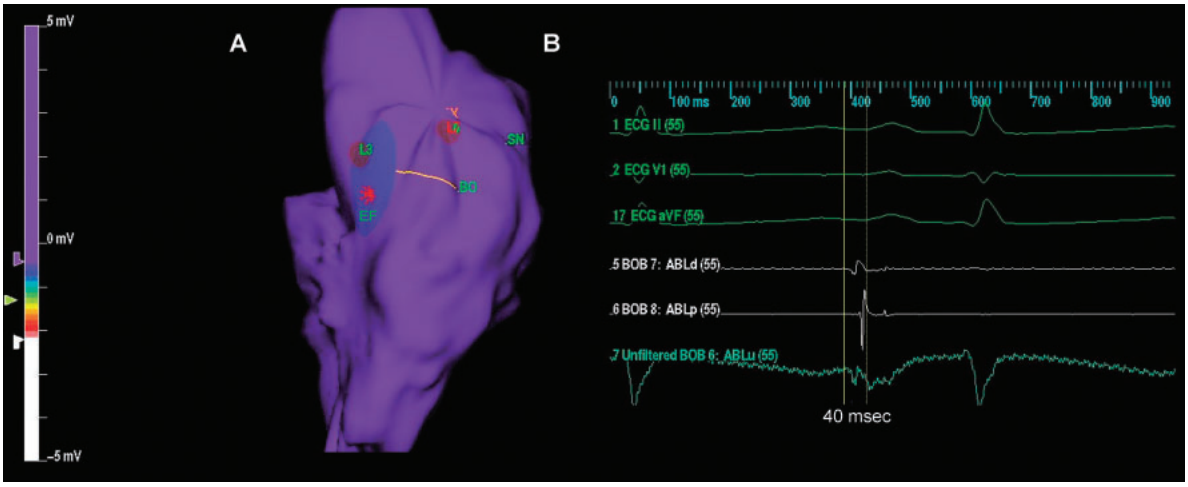

Figure 2
A: Posterolateral view of three-dimensional right atrial (RA) geometry reconstructed by EnSite system. Yellow line indicates preferential pathway. **EF**, ectopic focus; **BO**, breakout point; **SN**, sinus node. **B**: Local and unipolar atrial electrogram of APC (lower) preceded the onset of ectopic P wave in surface ECG (upper) by 40 msec.

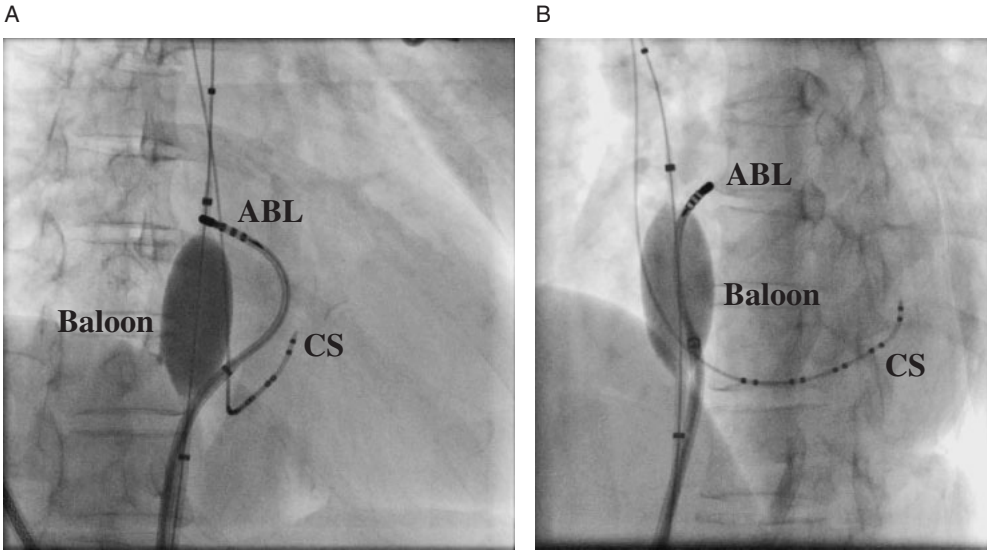

Figure 3 Right anterior (**A**) and left anterior (**B**) oblique views of the fluoroscopic RA imaging. **Baloon**, multielectrode array balloon catheter of EnSite system; **CS**, decapolar electrode catheter in the coronary sinus; **ABL**, ablation catheter.

RA activation demonstrated that APCs arose from an ectopic focus (**EF** in **Figure 2A**) which was located in high posterior RA in such a way that the superior vena cava orifice intervened between the compact sinus node (**SN**) and the **EF**. APCs shared the breakout point (**BO**) positioned in the uppermost crista terminalis (CT) and subsequent RA activation sequence with ordinary sinus beats (**Figure 2A**). An ablation catheter 4 mm in tip length (Ablaze, Fantasista, 7Fr., Japan Lifeline Co., Ltd., Tokyo, Japan) was inserted from the femoral vein, advanced into the RA and positioned to the EnSite-mapped target area (**Figure 3**). The earliest RA potential was recorded at the tip of the ablation catheter. This potential was 40 msec prior to the onset of the ectopic P wave in the surface ECG, which was confirmed by virtual electrograms that showed no double potentials[3] due in part to the limited resolution (not shown). Atrial activity of the unipolar electrogram showed completely negative deflection preceding the onset of the ectopic P wave by 40 msec (**Figure 2B**), suggesting that the tip of the ablation

catheter was located at the point of origin of the AT. Great care was taken to ablate the limited focus of AT while preventing RF-induced sinus node injury under ECG monitoring, i.e., RF energy was delivered at an intensity of 25 watts and a duration of 60 sec twice to the focus. During the RF current application, a burst of APCs was observed. P wave morphology during the APC burst was the same as that of spontaneous APCs. After the second RF application, frequent APCs disappeared and AT was not induced by isoproterenol. Thereafter, a temporary pacing lead was positioned to the right ventricular apex with a back-up rate of 30 bpm and the session was terminated.

Sinus node function was estimated in the EPS laboratory one week after the RF ablation. Sinoatrial conduction time (SACT) was evaluated by the return cycles immediately after atrial pacing for eight beats at a cycle length of 600 msec. Sinus node recovery time (SNRT) was defined as postdrive cycle length immediately after rapid atrial pacing for 30 sec at a rate up to 160 bpm. SACT was abbreviated from 181 to 21 msec and SNRT from 2427 to 2060 msec by intravenous atropine. Ambulatory monitoring was performed twice at the outpatient clinic, the first at one week and the second at one month after the ablation. During this monitoring, several APCs and a few segments of nocturnal sinus arrest with a maximum R-R interval of 2.9 sec were recorded. Based on the results of postablative ambulatory monitoring and the remarkable improvement of symptoms, permanent pacemaker implantation has not been necessary to date. Patient is asymptomatic without antiarrhythmic drugs 15 months after the ablation therapy.

Discussion

AT arising from upper RA sometimes exhibits bradycardia tachycardia syndrome. In this case, the onset of surface ectopic P wave was preceded by the earliest potential recorded by the tip of the ablation catheter located in the high posterior RA (**Figure 3**) by 40 msec, and this earliest potential corresponded to the onset of the negative deflection in the unipolar atrial electrogram (**Figure 2B**). This indicates that the tip of the ablation catheter (**EF** in **Figure 2A**) was positioned at the exact origin of AT. Furthermore, APCs shared a **BO** in the uppermost CT and subsequent RA activation sequence with ordinary sinus beats. This explains why surface P wave morphology of APCs was similar to that of sinus beats in this case (**Figure 1A**).

The electroanatomical mapping system is an important tool to map and ablate various kinds of arrhythmias, although its use in AT is still limited. Hoffmann et al[4] utilized the CARTO system in RF ablation which was successful in 85% of AT arising from RA. Higa et al[5] investigated the RA activation pattern in AT with the EnSite system. They demonstrated focal activation arises from the predominant origin, conducts *via* preferential pathway to the break-out point, where excitation spreads toward the entire RA. The EnSite mapping system in this case demonstrated findings compatible to their results (**Figure 2A**). Schmitt et al[6] emphasized the feasibility of the EnSite system in ten cases of AT ablation arising from RA. However, they did not apply RF current in two cases to the foci located in the anterosuperior RA which is in sinus node area. In this case, the predominant origin of the AT is the posterosuperior RA and the orifice of the superior vena cava exists between the **EF** and the **SN** in the reconstructed RA (**Figure 2A**). Therefore, the RF current was considered to be delivered safely to the focus of the AT.

RF ablation is recommended for treatment of AT, because AT is refractory to antiarrhythmic drugs and sometimes associated with sinus node dysfunction, as in this case.[2] Reportedly, sinus node dysfunction is expected to be restored after successful RF ablation for atrial fibrillation associated with SSS,[7,8] supporting the importance of ablation therapy for SSS coexisting with atrial fibrillation or flutter. In our case of AT, preablative EPS was impossible and postablative EPS suggested that sinus node automaticity is still impaired, i.e., SNRT (2060 msec), but not SACT (21 msec), was prolonged in the presence of atropine. Therefore, pacemaker implantation is still indicated for the long-term, but has been avoided so far, due to postablative monitoring and symptomatic improvement. This case indicates that RF ablation should be considered in drug-refractory focal AT associated with SSS.

In conclusion, this case demonstrated that noncontact, high resolution mapping is useful for ablation of AT arising from the high RA. This kind of AT ablation is favorable for the depressed sinus node function. Careful follow-up is necessary to monior the SSS, as SSS is usually progressive. However, this case demonstrates the effectiveness of the therapeutic option with EnSite-guided RF ablation for AT associated with SSS and may indicate presence of a "pacemaker-avoidable" bradycardia tachycardia syndrome in the ablation era.

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