Case Report

Catheter Ablation of Ectopic Atrial Tachycardia Originating from the Left Atrial Appendage using CARTOMERGE® System

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A 70-year-old woman was referred because of drug resistant and daily incessant palpitation attack. She had undergone two previous unsuccessful radiofrequency catheter ablations at another hospital. The physical examination, chest X-ray, and echocardiogram were all normal. The 12-lead ECG during tachycardia showed narrow QRS, short PR tachycardia and negative polarity of the P wave in leads I and aVL (Fig. 1A). The ECG monitor showed incessant tachycardia with warming-up phenomenon. Three dimensional electroanatomical map integrated with CT imaging (CARTOMERGE®, Biosense Webster Inc.) clearly revealed the radial activation pattern originating from the basalo-postero-inferior aspect of the left atrial appendage. Radiofrequency energy application at this site eliminated tachycardia permanently.
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Key words: Ectopic atrial tachycardia, Left atrial appendage, CARTOMERGE®, Ablation

Introduction

Radiofrequency (RF) catheter ablation of atrial tachycardia is a well established therapy. However, failure does occur because of the anatomical complexity. We are reporting a case with an ectopic atrial tachycardia originating from the left atrial appendage, which was successfully ablated using the latest three-dimensional electroanatomical mapping system (CARTO, Biosense Webster Inc.) for guidance.

Case report

A 70-year-old woman was referred to our institution for RF ablation procedure because of daily episodes of narrow QRS tachycardia resistant to pharmacological therapy. Two unsuccessful ablation procedures were previously performed on this patient.

During sinus rhythm the 12-lead electrocardiogram showed a normal P wave and QRS wave morphology (**Figure 1B**). During tachycardia, negative polarity of the P wave was noted in leads I and aVL along with a long RP interval (**Figure 1A**). Onset of tachycardia showed acceleration phenomenon.

Electrophysiologic study was performed in the fasting state after written informed consent was obtained. The patient was sedated by continuous infusion of propofol. A 5-Fr quadripolar and 6-Fr

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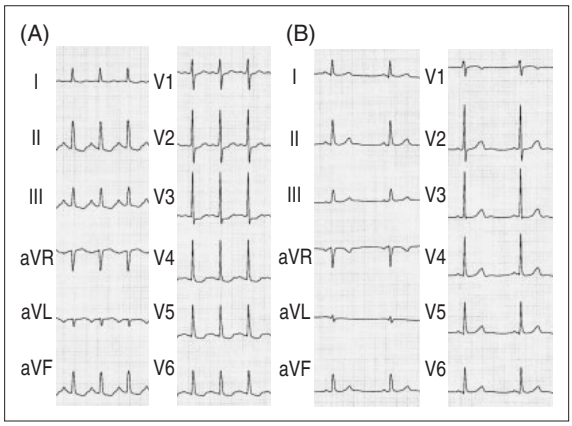

Figure 1 Twelve-lead electrocardiogram during atrial tachycardia (A) and sinus rhythm (B). During atrial tachycardia, P wave was negative in leads I and aVL, suggesting a left atrial appendage focus.

decapolar electrode catheter (EP star: Japan Lifeline, Livewire: St. Jude Medial) were introduced through the left femoral vein and positioned in the His bundle potential recording site and along the tricuspid annulus. Another 5-Fr decapolar catheter (SUPRA: Biosense Webster Inc.) was introduced through the right jugular vein and positioned in the coronary sinus. An additional 7-Fr quadripolar, deflectable catheter with a 4-mm tip electrode and a magnetic location sensor (NAVI-STAR, Biosense-Webster) was introduced through the right femoral vein, and was used for mapping. Another electrode catheter with a magnetic location sensor (REF-STAR, Biosense-Webster) was taped on the patient's back, and was used as the location reference for the electroanatomical mapping system. A bipolar electrogram from a pair of electrodes in the coronary sinus was used as the timing reference for the mapping system. Surface electrocardiograms and intracardiac electrograms were also monitored, recorded, and analyzed using a BARD pro system (BARD Electrophysiological Corporation). Electrical stimulation was performed using a digital stimulator (Nihon Koden, Tokyo, Japan).

No ventriculo-atrial conduction was observed during ventricular pacing from the right ventricular apex. Tachycardia initiated spontaneously without atrial extrasystole or jump of the AH interval. Onset of tachycardia showed acceleration phenomenon of the tachycardia cycle length. Spontaneous variation of A to A interval during tachycardia preceded variation of V to V interval. With these findings we diagnosed this tachycardia as ectopic atrial tachycardia.

Electroanatomical mapping of the right atrium (RA) and left atrium (LA) was performed during clinical tachycardia. The earliest activation of RA was recorded at the anterior wall of the high RA which was the putative Backmann's bundle region. Activation of the LA showed radial activation pattern and the earliest activation was recorded between the left atrial appendage (LAA) and the left pulmonary veins (**Figure 2B** and **C**). Three-dimensional LA integrated electroanatomical map and

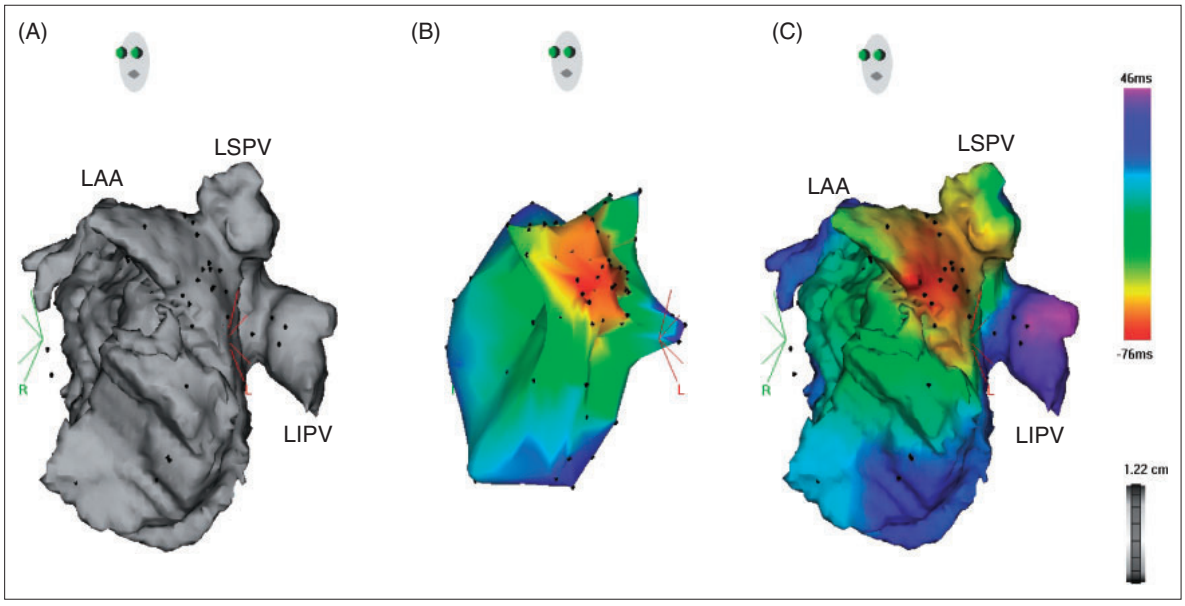

Figure 2 Three-dimensional CT image of the left atrium in this patient (A), left atrial activation map during atrial tachycardia (B), and integrated figure (C) as viewed in the left antero-lateral projection. Earliest atrial activation was recorded at the basalo-postero-inferior portion of the left atrial appendage. Mean surface-to-point distance was 2.03 ± 1.47 mm.

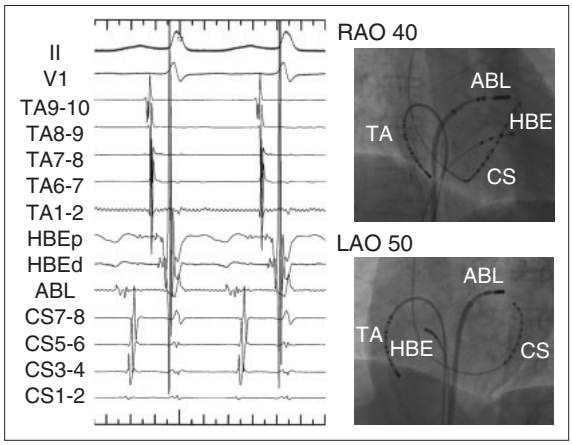

Figure 3 Electrogram recordings at the successful ablation site
Left: surface and intracardiac ECG during tachycardia
Right: catheter positions
Earliest and fractionated atrial activation was recorded at the basalo-postero-inferior portion of the appendage. RF application at this site terminated atrial tachycardia.
II, V1: surface ECG leads II, V1, TA 1–10: intracardiac electrogram recorded from distal, 2nd, 3rd, 4th, and 5th pair of electrodes from decapolar catheter (TA in radiograph) located along the lateral right atrial wall, HBE: His bundle electrogram, ABL: ablation, CS 1–8: intracardiac electrogram recorded from distal, 2nd, 3rd, and 4th pair of electrodes from decapolar catheter (CS in radiograph) situated inside the coronary sinus, d: distal, p: proxymal.

Figure 4 RF energy application at this site terminated tachycardia immediately.

computed tomography (CT) showed the earliest activation site was located at the basalo-postero-inferior portion of the LAA (**Figure 2C**).

At the earliest activation site, a widely split double atrial potential was demonstrated (**Figure 3**). The 2nd RF application at this site terminated tachycardia immediately (**Figure 4**). After successful ablation complete electrophysiological study was performed. Tachycardia became non-inducible even under aggressive pacing protocols with infusion of isoproterenol (1–2 μg/min).

Discussion

Catheter ablation for EAT was first reported by Walsh et al.[1] EAT is an uncommon form of supraventricular tachycardia sometimes leading to cardiomyopathy and is often resistant to pharmacological therapy.

EAT is commonly located in the crista terminalis, near the tricuspid and mitral annulus, at the ostium of the coronary sinus, at the apex of the triangle of Koch and at the ostium of the pulmonary veins. Recently, two studies[2,3] concerning EAT arising from LAA have been reported. Wang et al. reported[2] that the LAA was an uncommon site of origins for focal AT (representing 3% of the study population) and that focal ablation was safe and effective to treat this tachycardia. Yamada et al. reported[3] that the LAA was one of the common origins in EAT with LA origin and negative P wave in leads I and aVL indicating an LAA AT focus. In our case, surface P waves in leads I and aVL were negative, which was consistent with the previous report.

It was reported that atrial arrhythmia could be originating from the ligament of Marshall, which courses obliquely above the LAA and lateral to the left superior pulmonary vein. Therefore atrial arrhythmia originating from the ligament of Marshall may also be ablated in the basal-posterior region of the LAA. In this case, a fragmented atrial potential was recorded at the successful ablation site during tachycardia. On the other hand, during sinus rhythm only a single atrial potential was recorded. The observance of a single atrial potential suggested the focus of this atrial tachycardia was not the ligament of Marshall but the LAA. Normally the voltage of the atrial potential inside the LAA is high, but in this case the voltage of the atrial potential recorded at the successful site was relatively low. We speculated that this was because of the recurrent radiofrequency energy application during previous procedures in this region.

In this patient, identification of the location of the tachycardia focus was complicated, requiring not only conventional biplane fluoroscope but also a conventional electroanatomical mapping system, because there are three structures in this region, i.e., the LAA and the left superior and inferior pulmonary veins (PVs). With fluoroscopy, or conventional CARTO images, it is difficult to identify the three-dimensional spatial orientation of these three structures. Furthermore the muscular folds between left PVs and LAA are often narrow and make an acute angle. This can make it difficult to stabilize a catheter in this region. Using the CARTOMERGE® system, we created an atrial activation map with sampling focused on the left pulmonary veins and the LAA during tachycardia (**Figure 2**). With this map it was clearly demonstrated that the tachycardia focus was located at the basalo-postero-inferior portion of the LAA.

The CARTO system was first introduced to clinical eletrophysiologic study by Ben-Haim et al.[4] in 1996 and has been widely used for catheter ablation procedure targeting many complex arrhythmias. However, geometries reconstructed on conventional CARTO system have a resolution limited by the number of points acquired and variations in anatomy of the heart chambers are frequent. Recently, the CARTOMERGE® system was introduced[5] which enabled integration of high resolution images from MRI or CT imaging. This 3-D mapping system may have the potential to maximize the efficacy and minimize the risks of ablation.

Conclusion

We successfully ablated an ectopic atrial tachycardia originating from the left atrial appendage with the aid of the latest electroanatomical mapping system. The three-dimensional electro-anatomical map integrated with CT imaging clearly demonstrated the extensive structure and provided the necessary spatial orientation required for successful ablation.

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