Successful radiofrequency catheter ablation of scar-related atypical right atrial tachycardia with paroxysmal atrial fibrillation by using a three-dimensional mapping system

ABSTRACT
A 61-year-old woman was admitted to our institution with frequent episodes of palpitations and dyspnea caused by paroxysmal atrial tachycardia. She had a history of paroxysmal atrial fibrillation and atrial tachycardia and had previously undergone radiofrequency catheter ablation. An extensive area encompassing the crista terminalis and high septum in the right atrium was identified as the scar zone by voltage mapping. The activation map of the right atrium revealed slow activation at the crista terminalis surrounded by a low-voltage scar zone that spread centrifugally throughout the right atrium. Focal ablation at the site of earliest low amplitude and discrete signals at the crista terminalis immediately terminated tachycardia, which was no longer inducible thereafter. This case illustrates that 3-dimensional mapping may be helpful for identifying the mechanism of arrhythmia and unusual isthmus, and thereby facilitates successful ablation.

Key words: • atrial tachycardia • catheter ablation • 3-dimensional mapping

Introduction
Conventional techniques for radiofrequency catheter ablation provide less data regarding accurate spatial location and preclude accurate electroanatomical mapping of complex cardiac arrhythmia. Recent advances in electroanatomical mapping offer advantages over conventional mapping by reconstructing a 3-dimensional image of the cardiac chamber.

In this report, we describe a case of paroxysmal atrial tachycardia (AT) in which a 3-dimensional mapping system facilitated successful ablation.

Case
A 61-year-old woman presented with recurrent palpitations. Electrocardiography during the palpitations showed wide QRS tachycardia (Figure 1),
and 24–h Holter monitoring revealed frequent unsustained episodes of paroxysmal AT and atrial fibrillation (AF). She was previously diagnosed with paroxysmal AF 4 years ago, and it had been well-controlled with antiarrhythmic medication. However, paroxysmal AT with 1:1 ventricular conduction frequently occurred and the patient was highly symptomatic. Therefore, she underwent radiofrequency catheter ablation for paroxysmal AT 2 years ago. Focal ablation at the high right atrial septum eliminated AT during the previous ablation session and she had been stable for 2 years prior to this event. Echocardiography revealed a mildly reduced left ventricular ejection fraction (40.5%) and slightly enlarged cardiac chambers. The anteroposterior diameter of left atrium was 48.5 mm. Antiarrhythmic drugs were ineffective and sinus node dysfunction developed. She therefore decided to undergo catheter ablation for paroxysmal AT and AF.

An electrophysiologic investigation was performed by placing a duodecapolar catheter in the coronary sinus, a decapolar catheter in the high right atrium, and a quadripolar catheter in the bundle of His. First, the geometry of the left and right atrium were obtained using the NavX system (St Jude Medical Inc., St Paul, MN, USA). We eliminated 4 pulmonary vein potentials by circumferential antral ablation. Voltage mapping was performed in both atria: the area characterized by voltages of <0.1 mV was defined as a scar. An extensive area in right atrium, specifically the high and low crista terminalis, and the high right atrial septum were identified as scar zones (Figure 2). We then attempted to induce tachycardia by rapid atrial pacing. Sustained AT was induced with a cycle length of 367 ms. The earliest activation was observed at the mid–crista terminalis area (CS 19, 20), and the relative conduction of the right atrium to the left atrium was 2:1 (Figure 3A). The tachycardia cycle length shortened (328 ms) and the relative conduction of the right atrium to the left atrium became 1:1 (Figure 3B). In an electrophysiologic investigation, entrainment mapping

Figure 1. Baseline electrocardiography during palpitations showed wide QRS tachycardia. The mechanism was determined to be atrial tachycardia with 1:1 ventricular conduction during a previous electrophysiologic study.
excluded the cavitricuspid isthmus and left atrium as part of the tachycardia circuit. Additionally, an activation map in the right atrium was created. It revealed slow conduction at the crista terminalis surrounded by a low–voltage scar zone that spread centrifugally throughout the right atrium. The area was consistent with the site of earliest activation visualized in electrograms at 24 ms prior to P-wave onset (Figure 3B). Low–amplitude, discrete potentials were recorded at that site. Entrainment pacing showed perfectly concealed entrainment (post–pacing interval minus tachycardia cycle length of <10 ms). Therefore, this area was revealed as the critical tachycardia focus. Focal ablation at the site of earliest signal with an open irrigated tip catheter immediately terminated the tachycardia, which was thereafter non–inducible. Fluoroscopic and 3–dimensional images of the ablation sites are shown in Figures 4 and 5, respectively. The induction test was repeated and no AT or AF was inducible. The patient was successfully discharged without procedure–related complications and she has remained free of symptomatic recurrence of arrhythmia for 2 months.

**Discussion**

The present case shows that a single area of slow conduction at the crista terminalis may act as the critical tachycardia isthmus for atypical AT. This case further emphasizes the advantages of a 3–dimensional voltage and activation map to identify the mechanism of the tachycardia and slow–conducting isthmuses at uncommon sites. The slow–conduction area on the activation map was proved to be the critical isthmus by arrhythmia termination during ablation. Radiofrequency catheter ablation is the treatment of choice for several cardiac arrhythmias. The conventional approach using intracardiac electrograms during sinus rhythm or tachycardia has inherent limitations. Localization and demonstration
Figure 3. (A) Sustained atrial tachycardia was induced with a cycle length of 367 ms and the earliest activation at the mid-crista terminalis (CS 19, 20). (B) The tachycardia cycle length shortened (328 ms) and the relative conduction of the right atrium to left atrium was 1:1. The earliest activation with low amplitude and discrete potentials were recorded at the ablation catheter 24 ms prior to P-wave onset.

Abl: ablation, CS: coronary sinus, HRA: high right atrium.

of the focus or entire reentrant circuit with conventional mapping catheters remains difficult. Furthermore, conventional mapping techniques (i.e., pacing maneuvers) are limited by the risk of tachycardia termination or conversion to a nonclinical arrhythmia. Moreover, 2-dimensional fluoroscopic imaging limits the ability to evaluate several potential sites for ablation and to go precisely to the most suitable site. Recently, 3-dimensional mapping became popular during electrophysiologic investigations and catheter ablation. The mechanism of tachycardia can be easily determined, and the wave front propagation and the scar zone that contributes to the
tachycardia can be documented. Therefore, the use of a 3-dimensional mapping system may improve procedural outcomes and clinical success. In particular, the efficacies of 3-dimensional mapping of atypical atrial flutter or AT following cardiac surgery were reported. The accurate identification of tachycardia isthmus by creating a voltage and propagation map and then minimizing the ablation lesion may also avoid late recurrence of scar-related atypical flutter or AT.

In conclusion, 3D mapping may be particularly helpful in patients who have recurrent atrial flutter or AT following a previous ablation because it can identify the slow-conduction zone or breakthrough site and the scar zone easily—which can then be precisely targeted.

References