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Case Report

Radiofrequency catheter ablation of incessant atrial tachycardia in pregnant women with minimal radiation exposure: Lessons from two case studies

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ABSTRACT

During pregnancy, incessant tachyarrhythmias may result in hemodynamic compromise in both the expectant mother and the fetus. The use of antiarrhythmic drugs is typically not safe during pregnancy, and some tachycardias are refractory to pharmacologic treatment due to a significant autonomic imbalance. Catheter ablation is thought to be more effective than medical therapy, but carries the risk of radiation exposure to the fetus. We report two cases of hemodynamically unstable incessant atrial tachycardia (AT) in pregnant women. Both ATs resolved after three-dimensional electroanatomical mapping-guided radiofrequency catheter ablation with minimal fluoroscopic exposure. But one of the patients experienced a pulmonary embolism immediately after the procedure and miscarried.

<**Learning objective:** Although catheter ablation using electroanatomical mapping is an effective treatment for incessant atrial tachycardia in pregnant women and minimizes radiation exposure to the fetus, patients should be closely monitored during the peri-procedural period due to the risk of pregnancy-associated complications such as pulmonary embolism.>

Introduction

Incessant tachyarrhythmia during pregnancy is a difficult clinical problem to manage, since antiarrhythmic drugs have potential adverse effects on the fetus and some tachycardias are refractory to pharmacologic therapy [1]. Historically, physicians have been hesitant to perform radiofrequency catheter ablation (RFCA) due to concerns about fetal radiation exposure. We report two cases of incessant atrial tachycardia (AT) successfully resolved by RFCA using a three-dimensional (3D) electroanatomic mapping system with minimal radiation exposure.

Case reports

The first case was a 30-year-old woman at 17 weeks gestation who had been suffering from chest fluttering and New York Heart Association class III shortness of breath for two weeks. On physical examination, she had a significant jugular venous engorgement and S3 gallop. An electrocardiogram (ECG) showed narrow QRS tachycardia with a cycle length of 280 ms and QRS amplitude alternans (Fig. 1A). Echocardiography showed a reduced left ventricular ejection fraction (LVEF) of 38%, suggesting tachycardiomyopathy. After fetal evaluation and discussion with obstetricians, we concluded that RFCA might be the best option for this patient. The electrophysiological intervention was performed without sedation. During the procedure, the patient's abdomen and pelvis were shielded with a 0.25-mm lead apron to protect the fetus from radiation. After right groin puncture, we used a 12Fr Trio sheath (St. Jude Medical Inc., Minnetonka, MN, USA) and an 8Fr Schwarz left 1 long sheath (St. Jude Medical Inc.), and then positioned the mapping catheter minimizing radiation exposure (Fig. 1C). And we generated 3D electroanatomical maps (NavX, St. Jude Medical Inc.) using a 20-pole Lasso catheter (7Fr, Johnson & Johnson, Diamond Bar, CA, USA) to shorten the radiation time. The resultant high density activation map (over 350 points on bipolar electrogram) showed the focus of AT to be the sinus venosus (Fig. 1E), which matched the earliest activation site identified on bipolar catheter mapping (Fig. 1D). AT was neither entrained nor pace-terminated at the potential target site, suggesting a non-reentrant mechanism, and RFCA successfully terminated the tachycardia within 15 s of energy delivery. The total fluoroscopy time was 6 min, and the total radiation dose administered was 35.1 mGy. Normal sinus rhythm was subsequently maintained without further intervention (Fig. 1B). After the procedure,

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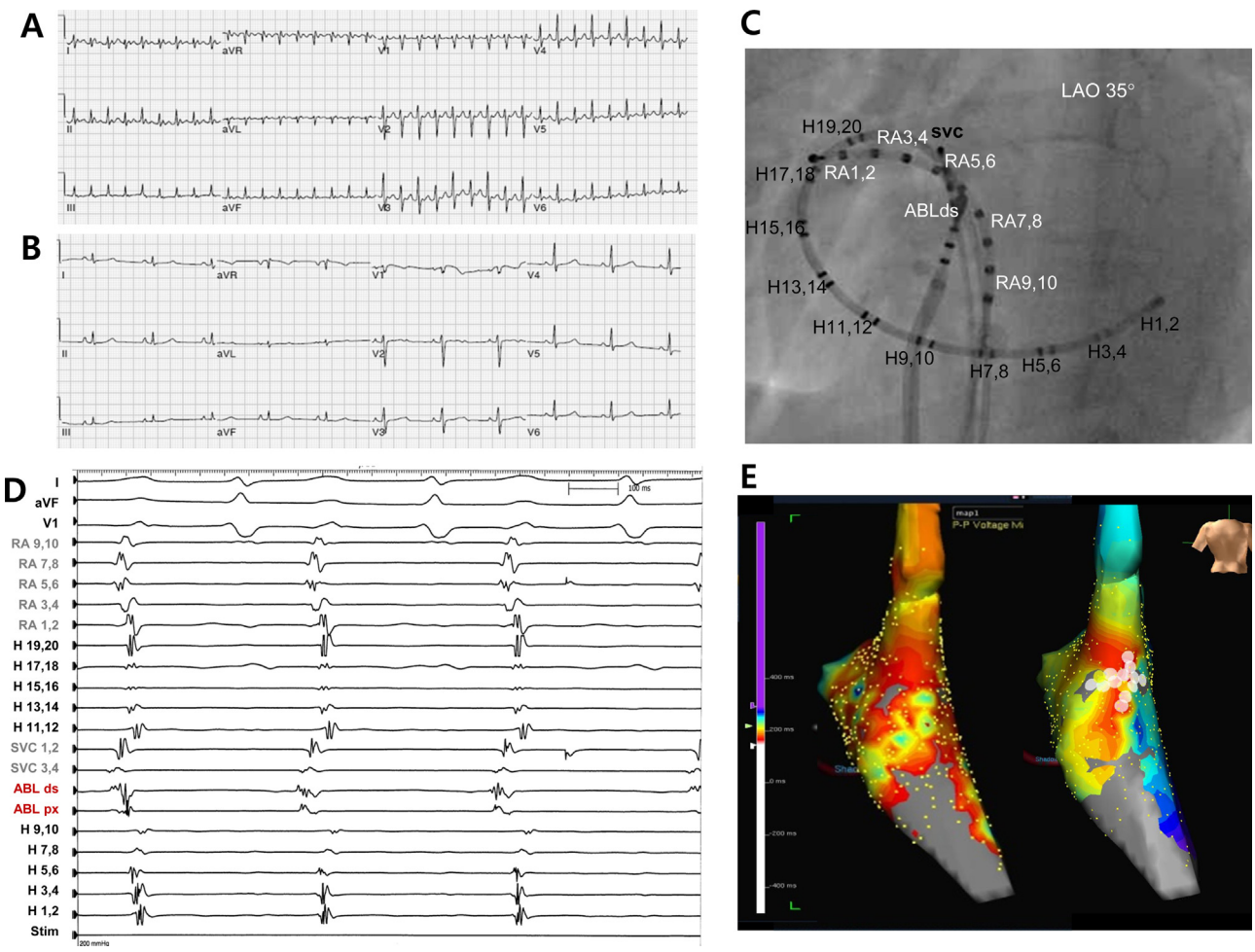

Fig. 1. (A) 12-Lead electrocardiogram (ECG) from the first case showing atrial tachycardia. (B) ECG after successful atrial tachycardia ablation. (C) Catheter positions in the left anterior oblique (LAO) 35° view. (D) Intracardiac recording during an electrophysiology study showing that the earliest atrial activation was recorded at the sinus venosus. (E) NavX 3D activation map (left) and voltage map (right) from the right posterior oblique view. The earliest activation site is localized at the border of the scar and the low voltage area on the sinus venosus. Ablation sites are depicted by white circles.

her LVEF improved from 38% to 68% on echocardiography, and the patient delivered a healthy full-term baby.

The second case was that of a 32-year-old woman at 21 weeks gestation who presented with incessant tachycardia and shortness of breath that had been worsening over the previous 2 months. Her AT was incessant despite receiving amiodarone and β-blockers, at which time the patient was referred to our facility. On physical examination, she had pulmonary and peripheral venous congestion and S3 gallop. An ECG showed AT with a heart rate of 160 bpm, negative P-wave polarity in V1 and aVR, and positive P-wave polarity in I, II, III, aVF, and aVL (Fig. 2A). Echocardiography revealed cardiomyopathy with a LVEF 18%. It was initially difficult to differentiate between tachycardiomyopathy, peri-partum cardiomyopathy, and acute exacerbation of dilated cardiomyopathy, although incessant AT was thought to be a major contributor to her heart failure symptoms as well as fetal distress. Therefore, after discussions with obstetricians and her family, we chose to perform RFCA. We used the same right groin approach for mapping and ablation in this second patient too, but, unfortunately, we did not use heparin. Pelvic protection with a 0.25-mm lead apron was also applied. An intracardiac electrogram showed the earliest AT activation site to be along the free wall of right atrium (RA) (Fig. 2C). We successfully mapped and ablated AT originating from this site after high density (over 400 points on RA) 3D electroanatomical mapping (NavX, St. Jude Medical Inc.; Fig. 2D and E). Total fluoroscopy time was 60 s and the total radiation dose administered was 13.5 mGy. At the end of procedure, the patient's condition began to deteriorate as she showed signs of severe hypoxemia, tachypnea, and hypotension. Her hypoxemia was not corrected by high-flow oxygen, and she was subsequently intubated and underwent artificial ventilation. Her alveolar–arterial oxygen gradient (A–a DO_2) was high (159 mmHg) and her plasma D-dimer level was extremely elevated (6478 ng/mL). Pregnancy is a risk factor for developing a pulmonary embolism (PE), and she had additionally undergone a transvenous catheter procedure. Intravenous unfractionated heparin was immediately infused for a clinical diagnosis of acute PE, although pulmonary computed tomography angiography was not conducted in order to avoid further radiation exposure. After several hours of heparinization and mechanical ventilation, the patient's vital signs stabilized but the baby did not survive. The patient recovered without complications after abortion and remained in sinus rhythm (Fig. 2B). Additionally, her LVEF improved from 19% to 40% during the 9-month follow-up period.

Discussion

AT is a relatively common arrhythmia during pregnancy, and typically self-limited. In some cases, however, the patient may develop incessant tachycardia which can induce tachycardiomyopathy [2,3]. Tachycardiomyopathy increases the risk of fetal

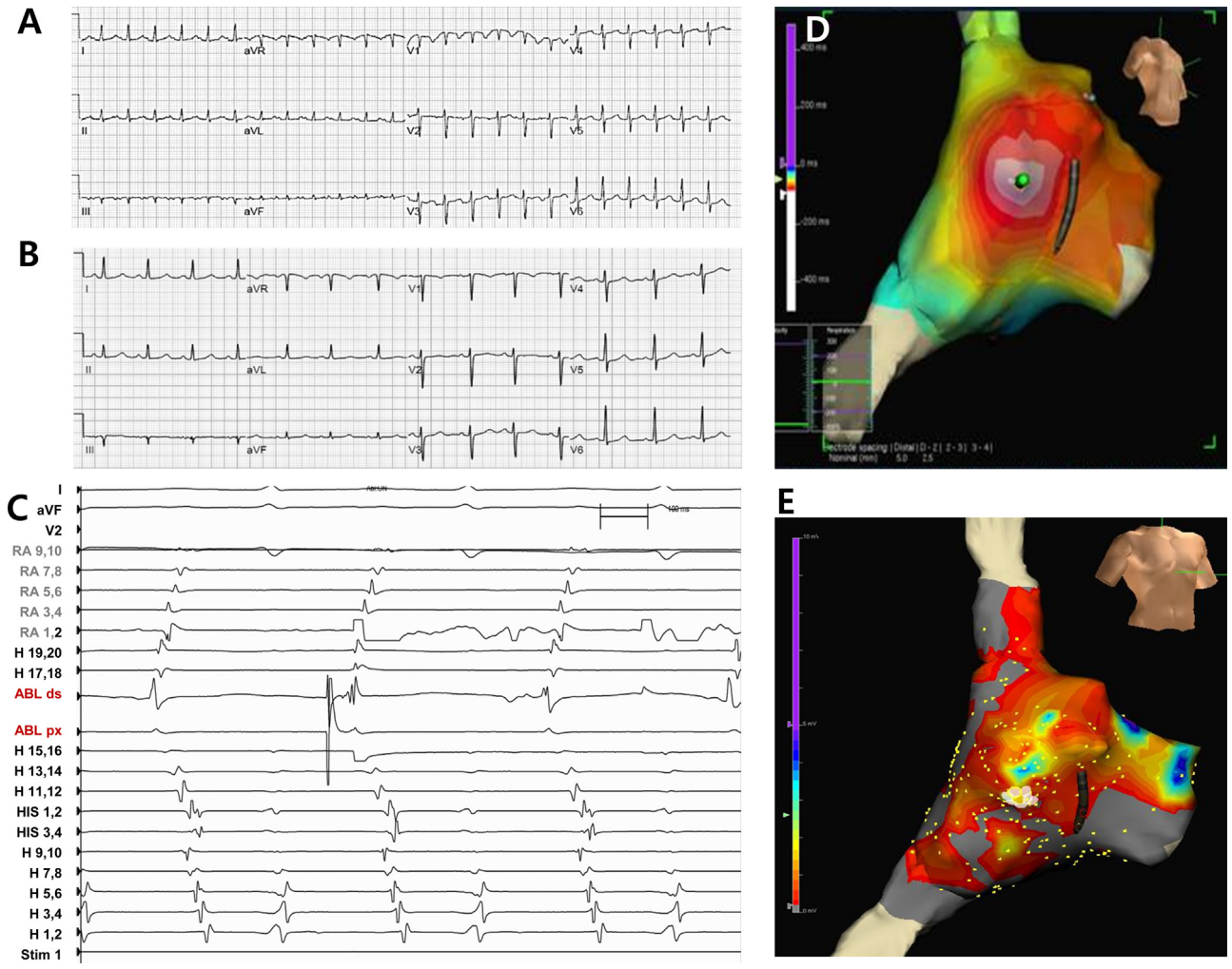

Fig. 2. (A) 12-Lead electrocardiogram (ECG) from the second case showing atrial tachycardia originating from the high crista terminalis. (B) ECG after successful atrial tachycardia (AT) ablation. (C) Intracardiac electrogram showing the earliest activation site of AT to be on the free wall of the right atrium (RA) (ABLds). (D) 3D electroanatomical map showing a centrifugal pattern of activation originating from the free wall of the RA. (E) Voltage map of the RA suggests a low voltage area around the tachycardia focus. Ablation sites are depicted by white circles.

distress and death [4,5]. Generally, antiarrhythmic drugs are not recommended during pregnancy due to the risk of adverse effects such as teratogenicity [1]. The American College of Cardiology/American Heart Association guidelines recommend RFCA in pregnant patients with poorly tolerated supraventricular arrhythmias that are refractory to pharmacologic therapy [6]. Low-dose radiation of <50 mGy has been shown to have no significant adverse effects on the fetus [7]. Moreover, 3D electroanatomical mapping [8] or intracardiac echocardiography [9] can further minimize radiation exposure.

It is important to consider the differences in physiology during pregnancy when deciding on a treatment strategy for AT, regardless of the known reduction in radiation and convenience of RFCA. Unfortunately, one of our patients experienced miscarriage due to a procedure-related PE. There were several factors contributing to this unexpected event. First, pregnant status itself increases the risk of thromboembolism [10]. All three factors in Virchows's triad (blood stasis, hypercoagulability, and endothelial injury) are relevant to a pregnant state. During pregnancy, mechanical venous compression by uterus and decreased mobility lead to venous stasis of lower extremity. Pregnancy is associated with a hypercoagulable state by physiological increase in pro-coagulant factors, such as factors VII, VIII, X, and von Willebrand factor, and decrease in anticoagulant factors, such as protein C and S. Endothelial injury also frequently occurs during pregnancy. Second, the associated heart failure contributed to the venous congestion and low extremity venous thrombosis. Third, she underwent RFCA which is known to increase the thrombogenicity, and catheter movement through the femoral vein might embolize the venous thrombosis. A series of above-mentioned risk factors must have led to the pulmonary thromboembolic event. Therefore, very careful venous catheterization and prophylactic heparinization are strongly recommended to prevent thromboembolic events in pregnant women undergoing RFCA. Heparin is a drug classified as Pregnancy Category C. But, heparin is generally considered safe to use during pregnancy, because it does not cross the placenta due to its large molecular weight [10]. In addition, there is no evidence to increase the risk of maternal complications, such as hemorrhage, abortion, or heparin-induced thrombocytopenia. If a pregnant woman has risk factors for thrombosis, such as past history of thromboembolism, inherited or acquired thrombophilia, and is undergoing an intravascular procedure, heparin can be used to prevent thromboembolic events.

The diagnosis of tachycardiomyopathy from peri-partum cardiomyopathy versus exacerbation of dilated cardiomyopathy is sometimes difficult to make, especially prior to assessing outcomes after rhythm control. The LVEF of the first patient was normalized, while that of the second patient was partially recovered after

successful rhythm control. Therefore, extreme caution should be taken when making diagnostic or therapeutic decisions for pregnant patients, and a thorough explanation of the risks and benefits should be given to the patient and her family prior to making decisions regarding management.

In conclusion, RFCA with 3D electroanatomic mapping technology is a viable therapeutic option for the treatment of tachyarrhythmias in pregnancy. However, the risk of potential pregnancy-specific complications such as PE requires close monitoring during the peri-procedural period.

Conflict of interest

The authors declare no conflict of interest.

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