Accessory Pathway Ablation during Atrial fibrillation in Ebstein Anomaly: Benefits of Intracardiac Echocardiography and 3D intracardiac electrograms visualisation

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Abstract

An 84-year-old woman with type B WPW with Ebstein anomaly was admitted with heart failure. She had rapid wide QRS tachcardia due to accessory pathway conduction associated with atrial fibrillation (AF). Since transesophageal echocardiography before catheter ablation showed a left atrial thrombus, ablation was performed using a 3D mapping system under AF. After marking the functional tricuspid anulus with intracardiac echocardiography, three dimensional intracardiac electrogram visualization (ripple map) during AF enabled clear identification of location of the accessory pathway. After ablation, there was no complication of cerebral infarction and heart failure improved.

Title

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Short title: accessory pathway ablation during AF in Ebstein

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Abstract

An 84-year-old woman with type B WPW with Ebstein anomaly was admitted with heart failure. She had rapid wide QRS tachcardia due to accessory pathway conduction associated with atrial fibrillation (AF). Since transesophageal echocardiography before catheter ablation showed a left atrial thrombus, ablation was performed using a 3D mapping system under AF. After marking the functional tricuspid anulus with intracardiac echocardiography, three dimensional intracardiac electrogram visualization (ripple map) during AF enabled clear identification of location of the accessory pathway. After ablation, there was no complication of cerebral infarction and heart failure improved.

Case Report

An 84-year-old woman was referred to our hospital due to heart failure with wide QRS tachcardia associated with AF. She was diagnosed as Wolf-Parkinson-White syndrome in 1996, however catheter ablation of the right posterolateral accessary pathway at that time was unsuccessful under fluoroscopy. She was not taking anticoagulants because her AF had not been noted. After administration of medication for heart failure and oral anticoagulant, transoesophageal echocardiography showed the presence of a thrombus in the left atrium. We decided to perform catheter ablation under AF.

An electrophysiological study (EPS) was performed under local anaesthesia, and the position of the tricuspid valve was mapped using the CARTO (Biosense Webster, Diamond Bar, CA) ICE catheter (Sound Star Biosense Webster) to evaluate the functional tricuspid anulus (TA). The functional TA was significantly deviated to the right ventricular side (Figure 1-A-1). The location of the functional TA was tagged using ICE (Figure 1-A-2,3). After insertion of the His-RV catheter, a high-density mapping catheter (pentaray Biosense Webster) and a ablation catheter (ThermoCool Smarttouch Surroundflow catheter (STSFc), Biosense Webster) were advanced into the right atrium and right ventricle, and activation maps were generated using an electroanatomical mapping system (CARTO 3 System Version 7, Biosense Webster). Mapping was done under AF and both ventricular and atrial electrogram were recorded on the tricuspid annulus. The activation timing was automatically annotated using a local activation time (LAT) annotation tool integrated in the CARTO system.

Activation mapping was performed concerning the body surface advanced referenced annotation (ARA) algorithm. The window of interest was set to cover the earliest V-wave of the endocardial ECG. Because of the mixture of narrow QRS via atrioventricular node and wide QRS complex with pre-excitation (Figure 2), the CARTO3 Confidence Module with pattern matching was used to acquire the points of the QRS automatically. The QRS morphology of maxmum pre-excitation was acquired, and the correlation threshold was set to [?]0.97. Position stability was set to 3 mm, and the mapping density was set to maximum. One thousand eight hundred forty-three points of maximum prepexcitation patterns were mapped in 15 min. Since the AF electrogram was recorded simultaneously, the earliest ventricular activity could not be detected by mapping using a LAT map (Figure3-A). We used 3D intra-cardiac electrograms visualisation (Ripple map (RM) module), which does not require annotation of the timing of excitation and reflects all excitations on the map even if there are multiple excitations in the window of interest. The RM clearly visualized the consistent propagation around TA via the accessary pathway (Figure3-B, supplemental movie). The fusion point of the ventricular and atrial activity was more to the right atrial side than the functional anulus mapped using ICE (Figure 1 B-2) and coincided with the location of the earliest ventricular activity expressed by RM (Figure 3 B-1,2,3). When the the fusion point was energised at a maximum of 35W, the wide QRS wave disappeared, and only the irregular narrow QRS beats were observed after 5 seconds of ablation (Figure 1 B-1). Postoperative echocardiography showed improvement in left ventricular ejection fraction, and the patient was confirmed with an Ebstein anomaly on transbusturacic echocardiography.

Discussion

In this case, a patient with heart failure due to rapid wide QRS tachcardia due to accessory pathway conduction with Ebstein anomaly underwent successful ablation of the accessory pathway during AF. There are two main points in this treatment. First, the location of the functional TA in the Ebstein anomaly was marked in advance using ICE, as the ablation failed 25 years ago and it is difficult to locate the TA anatomically on X-ray. Moreover, it has been recognized that catheter ablation should optimally target anatomical and not functional TA. In this case, the accessory pathway mapping was easily done by marking the anatomical annulus using ICE and the ablation target mapping was easily done using a 3D mpping system. Second, we succeeded in ablating the accessory pathway under AF. We used pattern matching to extract only the ventricle waves with maximum pre-excitation, and mapped only the electrogram of atrioventricular conduction via the accessory pathway. A RM, which can visually display all waveforms in chronological order, was used to visually display the earliest accessory pathway to the ventricle, and ablation was successfully performed.

Although other studies have reported that the RM is more useful than the LAT map for atrial tachycardia, this is the first report in which the RM was used to identify the accessory pathway during AF. Normally, annulus mapping is difficult during AF because the mixture of irregular atrial eletrograms. The conventional mapping method, the LAT map, assigns one premature point to one point and reflects the colour on the map, so that the propagation map and coherent map using LAT resulted in a disordered map and accessory pathway could not be identified. (Fig. 3-A) In the LAT map, the excitation timing at a specific time within a certain time window (window of interest) is indicated by colour, but annotation is required to determine the excitation timing. In 3D intra-cardiac electrograms visualisation including the RM, the annotation of the excitation timing is not necessary as all excitations are reflected on the map even if there are multiple excitations in the window of interest. Random excitation of AF became a small noise, and consistent propergation emerges.

Using the same method described as in this case report, patients with rapid wide QRS response via accessory pathway during AF who are difficult to defibrillate because of suspected thrombus in the left atrium can be ablated using accessory pathway mapping without defibrillation.

References

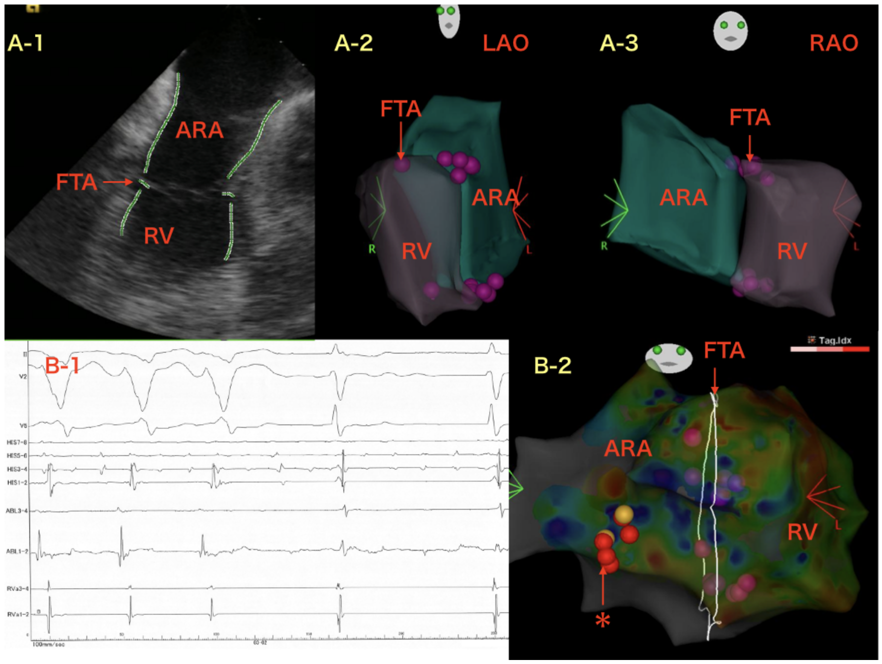
Figure legends

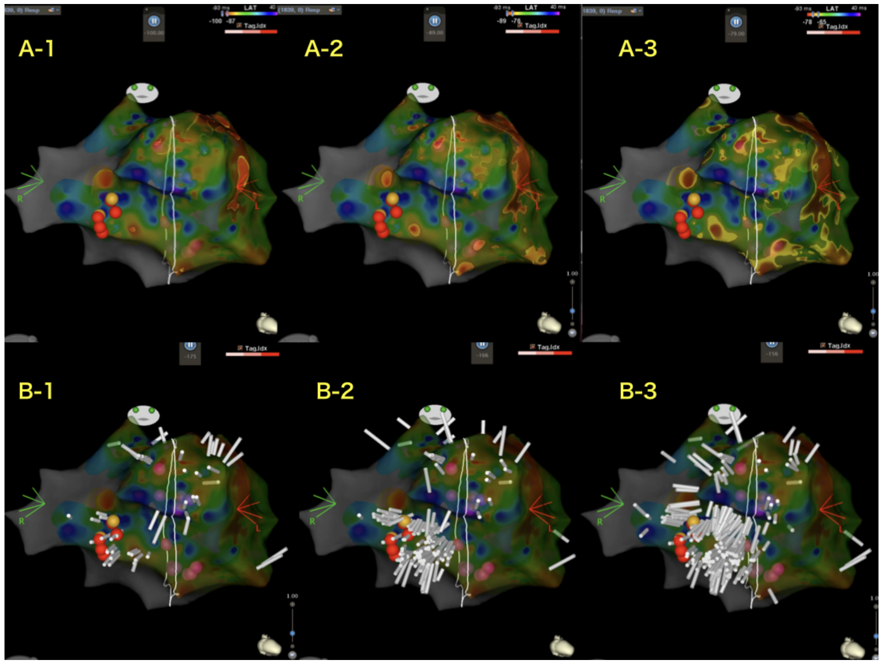
Figure 1: A: Intra-cardiac electrocardiogram mapping of the right atrium, right ventricle and functional tricuspid annulus. All mapping is done during inspiration and diastole. The purple tag represents funcitonal annulus. B-1: Endocardial electrocardiogram during successful ablation. The atrial and ventricular activity were fused at ABL1-2, and the atrial activity disappeared after ablation. B-2: 3D view of funcitonal annulus and ablation success point. The red tag was the ablation tag, the * is the success point. The functional annulus and the ablation success point were far apart.

ARA: arterized right atrium, RV: right ventricle, FA: functional tricuspid annulus, LAO: left anterior oblique, RAO: right anterior oblique

Figure 2: A: 12-lead electrocardiogram during rapid wide QRS response via accessory pathway during AF. Atrial waves were recorded at 9-10 of the Penta ray, indicating that the valve leaflets were being mapped. Narrow QRS conducts through the AV node, and wide QRS conducts through the accessory pathway. B: Maximum pre-excitation pattern matching data. The pattern of waveform acquisition was from pre-excitation to the end of the QRS in the wide QRS waveform via accessory pathway during atrial fibrillation. C: :Mapping of ventricular activity with maximum pre-excitation. Narrow QRS 1 was conduction through the AV node. No potential was acquired under waveform 1 by pattern matching. Wide QRS 2, a potentials was not acquired because pattern matching score is unde the correlation threshold. Wide QRS 3 was acquied a potential because pattern was matched. To acquire potentials from the preexitation of the wide QRS to the end of the QRS, waveforms in the range shown in the figure were acquired.

Figure 3: A is propagation map using LAT resulted in a disordered map and B is Ripple map (RM). A, B and C, in that order, are still images of 10msec each. They are in chronological order from 1 to 3. The map A can be seen that the propagation does not identify the acesory pathway. The map B was used to identify the accessory pathway during AF. The ripple map bars show the tricuspid annulus passing through the accesory pathway as the earliest in the timeline. The red and pink tags are ablation tag. See supplement movie 1.

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