Detection of an epicardial accessory pathway using the novel algorithm during ultra-high-density mapping

Taisuke Nabeshima, MD, Shota Muraji, MD, Hitoshi Mori, MD, PhD, Naokata Sumitomo, MD, PhD, FHRS

From the Department of Pediatric Cardiology, Saitama Medical University International Medical Center, Saitama, Japan.

Introduction

Although identifying accessory pathways (APs) is usually not difficult,[1] we present here the efficacy of the new functional module, Lumipoint™ (Boston Scientific, Washington, DC), to find epicardial APs.

Case report

A 40-year-old man was referred to our hospital for catheter ablation of recurrent palpitations lasting more than 10 months. He was diagnosed to have a complete transposition of the great arteries, inlet-type large ventricular septal defect, and severe pulmonary valve stenosis, and underwent a Fontan operation with an intra-atrial fenestrated lateral tunnel at the age of 12 and tricuspid valvoplasty at the age of 38. Monomorphic premature ventricular contractions (PVCs) and an intermittent preexcitation (Figure 1A) were documented by electrocardiogram and Holter monitoring.

After written informed consent was obtained, a decapolar catheter was placed in the cavopulmonary conduit, and a quadripolar catheter was retrogradely placed in the right ventricle apex to record and pace the right atrium and right ventricle. Because the fenestration of the cavopulmonary conduit was too high, a trans-baffle puncture in the native tissue just below the baffle using a radiofrequency (RF) needle was made to insert the Orion catheter (Boston Scientific, Washington, DC) and ablation catheter into both atria.

An activation map of both atria and the left ventricle (LV) during sinus rhythm was obtained by the Rhythmia HDx™ mapping system (Boston Scientific, Washington, DC) using an Orion catheter. An electrophysiological study revealed intermittent antegrade and continuous retrograde conduction of the AP located on the lateral wall of the left atrium (LA). An activation map during sinus rhythm showed that the earliest ventricular activation site did not exist around the mitral annulus but was located in the LV, and it looked like the wavefront from the atrium seemed to "skip" the annulus and enter the ventricle (Figure 1B). This unique conduction pattern was also confirmed by the Lumipoint module, which highlighted the local electrogram when the wavefront propagated from the LA to the LV (Supplemental video). The AP potential in the LA and local ventricular wave at the earliest ventricular activation site were identified at the onset of the delta wave (Figure 1C). However, the ventricular wavefront at the mitral annulus was recorded later than the onset of the delta wave, and no AP potentials were documented at the earliest ventricular activation site (Figure 1C). Though we could not introduce any tachyarrhythmias, it was still possible that the AP was the cause of his palpitations, and it also could cause his hemodynamic condition to deteriorate owing to his single ventricular physiology Therefore, we decided to ablate the AP. The first delivery of RF energy (35 W, 60 seconds) on the atrial side of the AP potentials successfully eliminated the antegrade and retrograde conduction of the AP.

KEY TEACHING POINTS

- Lumipoint software interprets the electrogram data from the Rhythmia mapping system (Boston Scientific, Washington, DC) and automatically highlights the activated area of any chosen period.
- Skyline indicates the surface area of the activated myocardium, and the period when the propagation converges or passes through an accessory pathway is illustrated as a valley on the graph.
- This software is useful for finding the precise location of accessory pathways, especially in patients with epicardial accessory pathways.

KEYWORDS Catheter ablation; Epicardial accessory pathway; Fontan procedure; High-density mapping; Lumipoint; Supraventricular tachycardia (Heart Rhythm Case Reports 2021;7:593–595)

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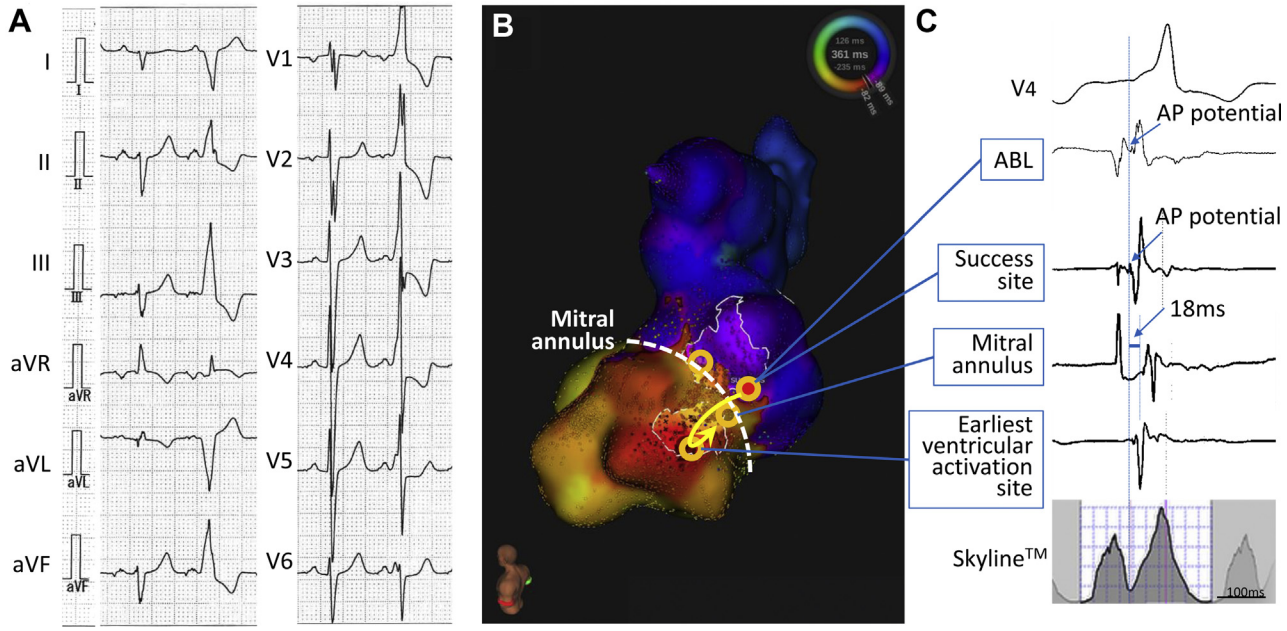

Figure 1 Electrocardiograms (ECG), activation mapping, and the local electrograms. **A:** A 12-lead ECG of sinus rhythm showing the intermittent appearance of delta waves. **B:** Activation mapping and Lumipoint (Boston Scientific, Washington, DC). An activation map illustrating that the activation wavefront just reached the left ventricle via the accessory pathway during sinus rhythm. The area that contained the active electrogram during that time is highlighted by the Lumipoint module as well. Note that both the earliest ventricular activation site and ablation successful site are geographically away from the mitral annulus. Lumipoint allowed visualization of the skip activation over the mitral annulus. The yellow arrow indicates the possible activation propagation along with the accessory pathway. **C:** Local electrogram of the successful ablation site. The local electrograms of the successful ablation site, mitral annulus, and earliest ventricular activation site are shown in this figure. The blue dashed line indicates the timing of the onset of the QRS wave in lead V_4. Note that the accessory pathway (AP) potential was recorded at the same time as that at the successful ablation site and is indicated by the dashed line, and the earliest ventricular activation site at the mitral annuls is followed 18 ms after by the successful ablation site. The area that contains the AP potentials is highlighted by focusing the period of the trough of the Skyline function. See the text for further detail. ABL = electrocardiogram of ablation catheter.

Discussion

An overview of the Lumipoint module used along with the Rhythmia mapping system

Lumipoint is a new functional module of the Rhythmia mapping system, and it differs from the conventional activation mapping in that it can highlight the area where the local electrograms of interest are located by means of an algorithm that depends on the consistency of the other electrodes nearby.[2] Several reports have been published on its usefulness for identifying the critical isthmus and abnormal diastolic potentials of ventricular tachycardia, atrial tachycardia, and APs,[3–5] and its safety and efficacy are proven in patients with congenital heart disease.[6] Rhythmia is also a very useful tool for finding the optimal ablation point for an AP by using dual-chamber mapping.[7] However, Lumipoint operates with a different algorithm than the conventional activation mapping algorithm. It can be used as a validating tool when we encounter an unusual activation propagation. In this case, we were confident with our diagnosis, as the wavefront skipped from the LA to the LV because of the consistency of both systems.

It is also beneficial from the therapeutic point of view. Skyline™ is a supplemental function of Lumipoint that indicates the surface area that has activation at any chosen time within the given map, whether it is atrial, ventricular, or both. Thus, the timing when a propagation converges within a slow conduction zone or an AP is illustrated nadir to the graph. So, it is easy to find the optimal ablation site retrospectively by investigating the local electrograms within few minutes. We first set the timing of the Lumipoint to the time when the Skyline showed the trough of the graph; then we were able to easily search for the optimal ablation site retrospectively by investigating the local electrograms within the highlighted area. We could also find an AP potential by searching for an optimal electrogram within the site where the Lumipoint was highlighted.

Epicardial accessory pathway between the left atrial appendage and left ventricle

In this case, both the atrial end of the AP where an AP potential was recorded and earliest ventricular activation site were away from the mitral annulus. The incidence of epicardial APs between the left atrial appendage and LV seem to be quite low, and there are only 5 case reports so far. Di Biase and colleagues[8] reported 2 adult cases that had been successfully ablated with an irrigated-tip catheter. Mah and colleagues[9] reported 3 cases, all of which had a very short AP effective refractory period below 200 ms. Those patients were surgically treated because they had broad or multiple connections to the LV and left coronary artery injury caused by high-power RF delivery was of concern. Later, Benhayon and colleagues[10] reported a pediatric case in which the AP was successfully ablated by an irrigation catheter after confirming that the ablation site was distant from the coronary

artery by using intracardiac echocardiography. Besides, the proximity to the coronary artery was less likely because the ablation site was not in the left atrial appendage and the ablation was completed without any complications.

Conclusion

Lumipoint, along with the ultra-high-density Rhythmia mapping system, is useful for identifying the precise location of epicardial APs even in patients with complex congenital heart disease.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.hrcr.2021.05.017.

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