Received: 11 June 2020 | Revised: 20 August 2020 | Accepted: 11 September 2020

DOI: 10.1002/ccr3.3760

CASE REPORT

Clinical Case Reports Open Access WILEY

A case of accessory pathway mapped with ultra-high-resolution mapping led to a coronary sinus diverticulum

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Abstract

Ultra-high-resolution mapping is useful in the ablation of accessory pathways. However, in patients with accessory pathways in the coronary sinus (CS) diverticulum, treatment with endocardial ablation may be challenging. Patients suspected of having subepicardial accessory pathways may require the examination of the venous anomaly using CS angiography.

KEYWORDS

accessory pathway, catheter ablation, coronary sinus diverticulum, high-density mapping, Wolff-Parkinson-White syndrome

1 | INTRODUCTION

A patient with Wolff-Parkinson-White syndrome underwent catheter ablation with ultra-high-resolution mapping, which suggested the presence of an accessory pathway in the posterior mitral annulus. We could not treat it from the endocardial side. However, angiography identified a coronary sinus diverticulum, and the pathway was successfully ablated at its neck.

The Rhythmia system™ (Boston Scientific), which visualizes cardiac excitation propagation with extremely high resolution, is a useful mapping tool for accessory pathway ablation.[1-3] In this study, we report the case of a patient who underwent catheter ablation for symptomatic Wolff-Parkinson-White (WPW) syndrome using the Rhythmia system, but was difficult to treat owing to the presence of a diverticulum in the coronary sinus (CS).

2 | CASE HISTORY

The patient, a 29-year-old woman, was diagnosed with WPW syndrome at the age of 10. She had occasional palpitations and underwent a follow-up with no treatment because of infrequent symptoms. Recently, she was admitted to our hospital for catheter ablation owing to increased palpitations. There were no abnormal physical findings on admission (chest X-ray or cardiac ultrasound showed no findings suggestive of organic heart disease). The 12-lead electrocardiogram (ECG) showed the following results: The delta wave polarity was positive in lead I and negative in leads II and aVF, and the amplitude of the R wave was greater than that of the S wave in lead V1 (Figure 1).

3 | ELECTROPHYSIOLOGICAL STUDY AND CATHETER ABLATION

A 6-Fr 10-pole catheter (Abbott Technologies) was placed in the coronary sinus. A 6-Fr 12-pole catheter (Japan Lifeline) was placed in a region extending from the bundle of His to the right ventricular apex. Regarding the intracardiac potentials during sinus rhythm, the site of the earliest ventricular activation was the CS (7-8) in the posterior mitral annulus, matching the sequence of the earliest atrial activation during right ventricular apex pacing (Figure 2A,B). Tachycardia, with a cycle length of 336 msec, was induced by stimulation with a basic cycle of 600 msec and an S1-S2 interval of 320 msec. The site of the earliest atrial activation during tachycardia matched the sequence during right ventricular apex pacing. These results led to the conclusion that her tachycardia was orthodromic atrioventricular reciprocating tachycardia, and the accessory pathway in the posterior mitral annulus was part of its circuit (Figure 2C).

To perform mitral valve annulus mapping, an Orion catheter (Boston Scientific) was placed in the left atrium using a steerable sheath (Agilis, Abbott Medical) and an intracardiac echo catheter was used for transseptal puncture. The ultra-high-resolution map of the atrial wall next to the posterior mitral annulus during right ventricular pacing, presented in Figure 3A, shows the propagation from the ventricle to the atrium at the marker in the figure (6 o'clock direction in the mitral valve annulus). Figure 3B shows the propagation during sinus rhythm. The marker in the figure shows that propagation from the atrium to the ventricle and yellow marker occurred at the site of the earliest atrial activation during right ventricular apex pacing. Thus, detailed mapping of the accessory pathway was performed.

When the ablation catheter was placed at the site of the earliest activation in the atrial wall next to the posterior mitral annulus detected by the Rhythmia system, the local potential of the catheter detected a preceding A wave during right ventricular apex pacing. Hence, the site was ablated (Figure 4). However, additional ablation of the surrounding tissue did not lead to the ablation of the accessory pathway. The treatment strategy was reviewed since lead II of the 12-lead ECG showed a negative delta wave. Therefore, the patient was suspected of having a subepicardial accessory pathway and underwent CS angiography via a catheter placed in the CS. The angiography identified a diverticulum with a neck extending downward at the site of CS 7-8 (about 1 cm from the CS ostium) (Figure 5). The neck of the CS diverticulum was attached to the main trunk. During angiography, contraction of the diverticulum before ventricular systole was also observed. When an ablation catheter was placed at the neck of the diverticulum (Figure 5), a potential preceding the endocardial local potential was observed during right ventricular apex pacing (Figure 6A). The accessory pathway was blocked in about 6 seconds after ablation of this site with 20w (Figure 6B). The ablation was completed by additional electrical stimulation of the surrounding tissue. Figure 7 shows all the ablated sites. The neck of the diverticulum in accessory pathway ablation matched the sequence shown by the Rhythmia system. During the postoperative 6-month follow-up, the accessory pathway did not recur.

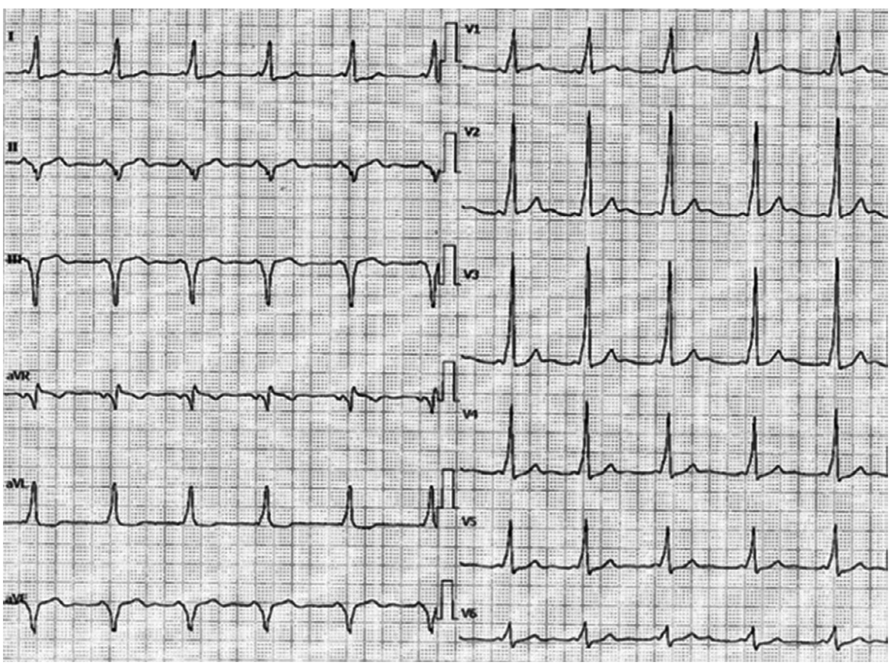

FIGURE 1 The 12-lead electrocardiogram during sinus rhythm. Delta wave polarity was positive in lead I and negative in leads II and aVF, and the amplitudes of the R wave was greater than that of the S wave in lead V1

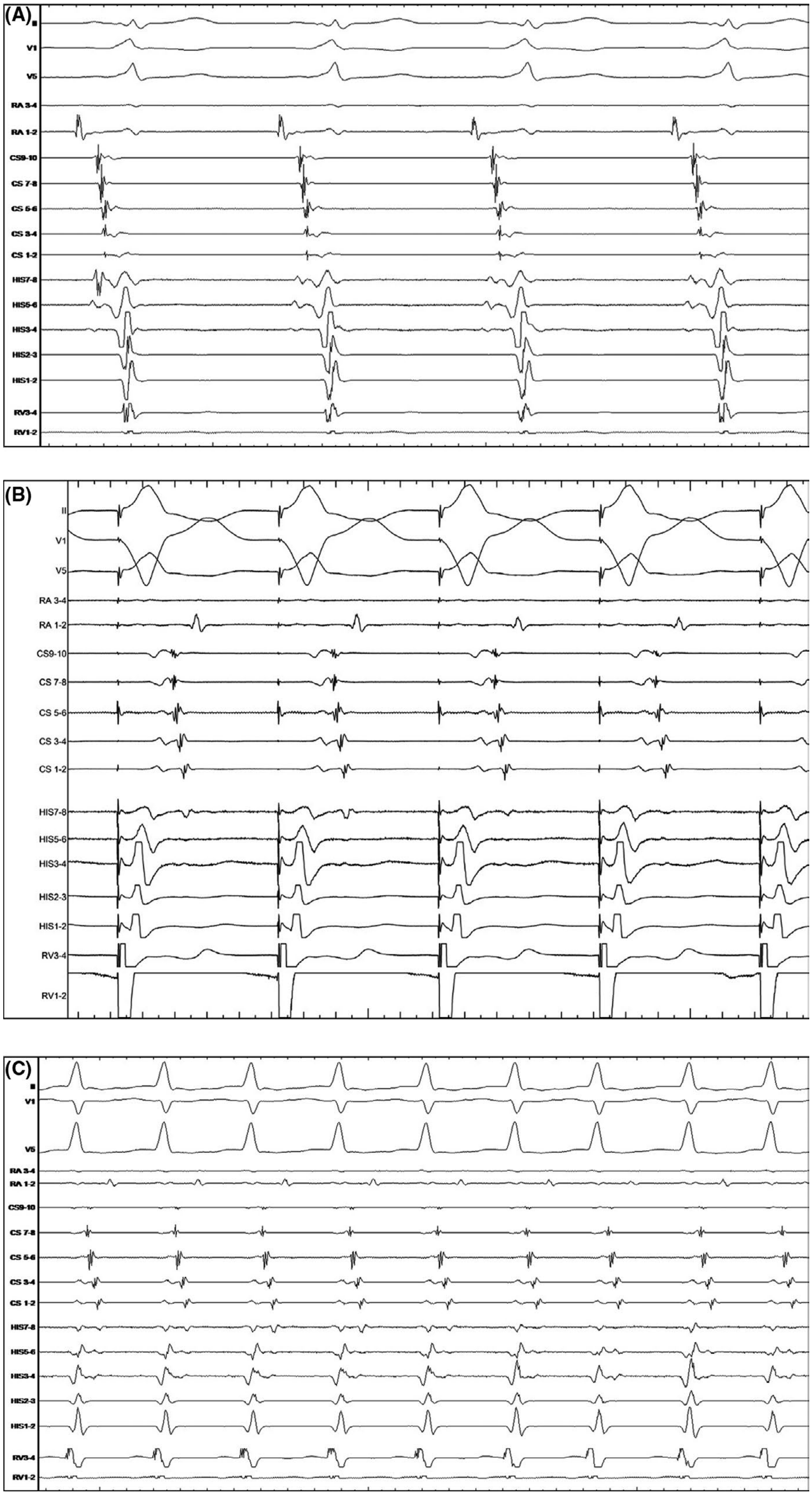

FIGURE 2 A, Intracardiac electrocardiogram (ECG) during sinus rhythm. B, Intracardiac ECG during right ventricular apex pacing. An accessory conduction pathway was detected at coronary sinus 7-8 (the posterior mitral annulus). C, Intracardiac ECG during tachycardia. The site of the earliest atrial activation during tachycardia matched the sequence during right ventricular apex pacing. Therefore, her tachycardia was concluded to be orthodromic atrioventricular reciprocating tachycardia, and the accessory pathway in the posterior mitral annulus was part of its circuit

4 | DISCUSSION

Based on the algorithm for identifying accessory pathways using the 12-lead ECG by Arruda et al,[4] the accessory pathway in the patient in this study was expected to be identified in the posterior mitral annulus. Therefore, ultra-high-resolution mapping was used to map the accessory pathway. Mapping using the Rhythmia system clearly visualized the

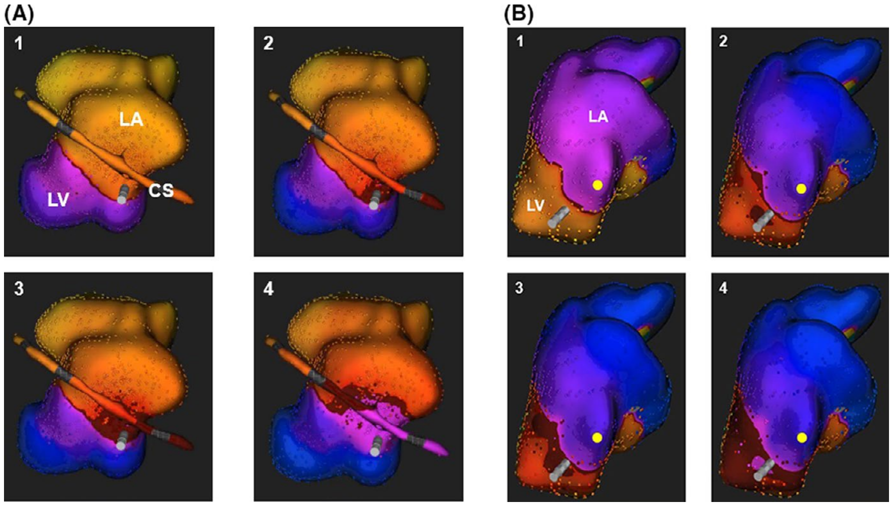

FIGURE 3 A, Ultra-high-resolution map of the atrial wall next to the posterior mitral annulus during right ventricular pacing. The marker in the figure shows propagation from the ventricle to the atrium in the posterior mitral annulus near the ostium of the coronary sinus. B, Ultra-high-resolution map of the atrial wall next to the posterior mitral annulus during sinus rhythm. The marker in the figure shows propagation from the atrium to the ventricle. The yellow tag indicates the site of the earliest atrial activation during right ventricular apex pacing

FIGURE 4 Intracardiac ECG of the site of ablation of the atrial wall next to the posterior mitral annulus. When the ablation catheter was placed at the site of the earliest activation in the atrial wall next to the posterior mitral annulus, detected by the Rhythmia system, the local potential of the catheter detected a preceding A wave during right ventricular apex pacing

atrial and ventricular attachments to the accessory pathway and the continuous potential between the atrium and ventricle at these sites. However, electrical ablation of the accessory pathway was not possible in this site. According to the ECG algorithm,[2] the delta wave (negative in lead II) shows the presence of subepicardial accessory pathways. In our patient, the presence of the accessory pathway in the posterior mitral annulus was first suspected. However, unsuccessful endocardial ablation led to the consideration of the presence of an epicardial collateral pathway. This led to the identification of the CS diverticulum using angiography and rapid and successful ablation at the neck of the CS diverticulum. The results suggest the importance of the examination of venous anomalies using CS angiography in patients suspected of having an accessory pathway in the posterior septum or the posterior mitral annulus.

In many cases, epicardial pathways are observed in the posterior septum or the region of the left posterior wall (eg, the middle cardiac vein [MCV] and the CS diverticulum [venous anomaly]). According to previous studies, an accessory pathway is usually observed in the MCV, but rarely in the CS diverticulum.[5] In a study of surgical treatment of WPW syndrome, patients with an accessory pathway in the posterior septum, a CS diverticulum was observed in six of 65 patients. The study suggested the presence of an accessory pathway was at the neck of diverticulum in all patients.[6]

These diverticula contain myocardial fibers that connect both the ventricle and CS myocardial coats. The CS myocardial coat, present in all individuals, is anatomically and electrically connected to both atria at the site of the accessory connection.[5] Moreover, there is a report of a successful ablation of an accessory pathway in the neck of a CS diverticulum.[7]

In this study, the diverticulum was contracted prior to ventricular systole. Therefore, activation may have propagated

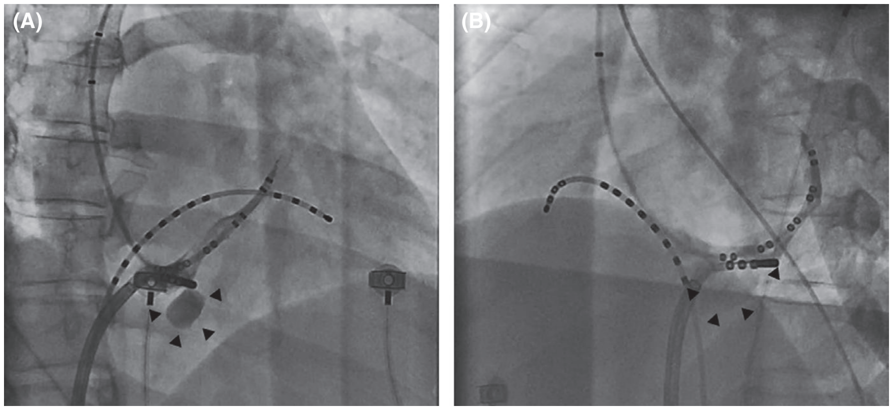

FIGURE 5 Coronary sinus (CS) angiography. CS angiography identified a diverticulum with its neck extending downward at the site of CS 7-8 (about 1 cm from the CS ostium)

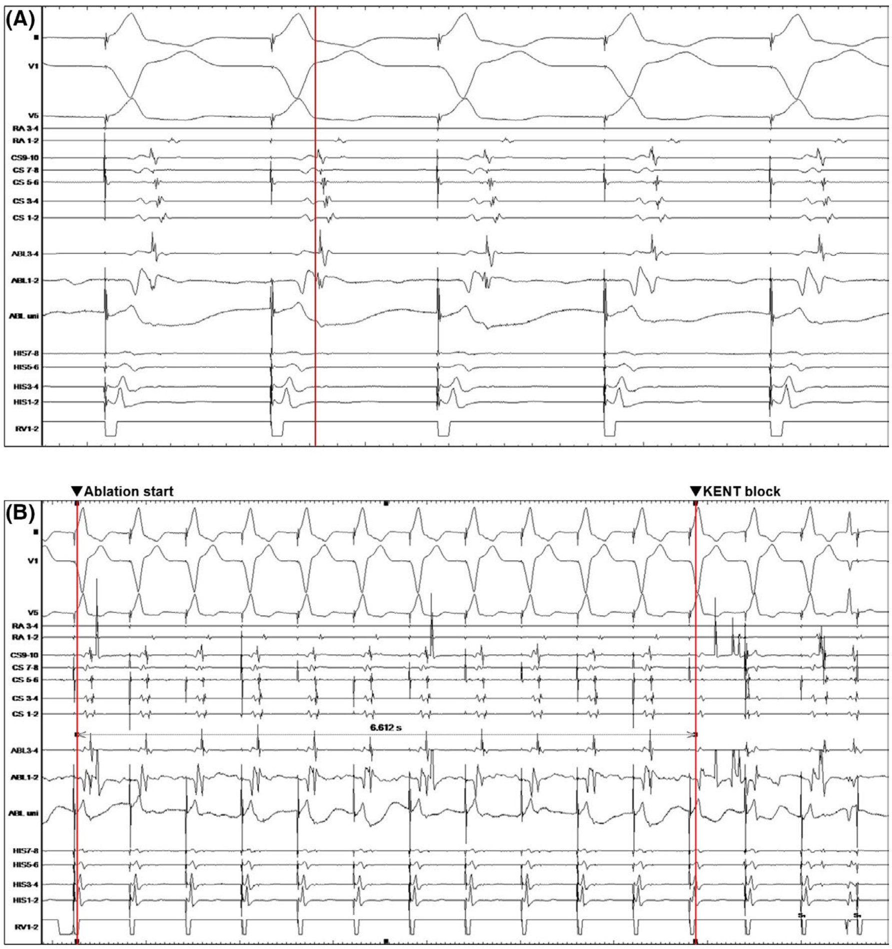

FIGURE 6 A, Intracardiac echocardiogram (ECG) during ablation of the neck of a CS diverticulum from within the CS. When an ablation catheter was placed at the neck of the diverticulum, an A wave preceding the wave detected at the endocardial site of ablation was observed during right ventricular apex pacing. B, Ablation at the neck of the CS diverticulum. The accessory pathway was blocked in about 6 seconds after the ablation of this site

from the atrium, via the CS myocardial coat, to the neck of a diverticulum, then to the muscle around the diverticulum, and finally to the ventricle.

5 | CONCLUSION

In this study, a patient with WPW syndrome underwent catheter ablation with ultra-high-resolution mapping. The mapping accurately detected the propagation. However, endocardial ablation did not lead to the block of the accessory pathway. Retrograde CS angiography confirmed the presence of a CS diverticulum. The ablation of the neck of the diverticulum led to the blocking of the accessory pathway. In patients with an accessory pathway in CS diverticula, it may be challenging to block the accessory pathway using endocardial ablation. Patients with subepicardial accessory pathways, as suggested by the preoperative ECG,

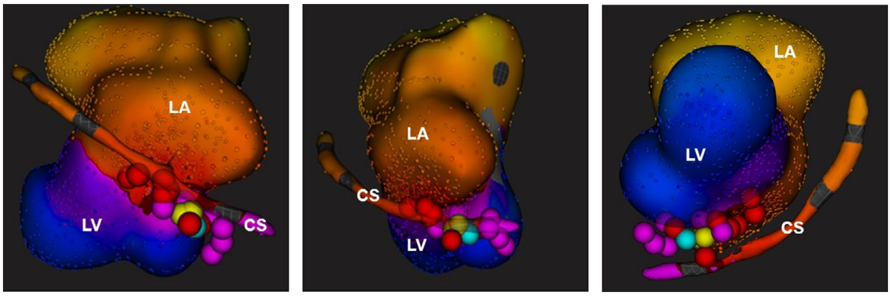

FIGURE 7 The ablation sites in this study. ● The yellow tag indicates the site of the earliest atrial activation and the site of the first endocardial ablation during right ventricular apex pacing, as shown by the Rhythmia system. ● The red tag indicates the site of additional ablation in the endocardium. ● The blue tag indicates the site of ablation in the neck of the diverticulum (successful ablation of the accessory pathway). ● The pink tag indicates the site of additional ablation from within the CS

may require examination of the venous anomaly using CS angiography.

ACKNOWLEDGMENTS

We gratefully acknowledge the co-medical staff working on our ablation team. Consent statement: Published with written consent of the patient.

CONFLICT OF INTEREST

None declared.

AUTHOR CONTRIBUTION

YS: conception and design of study, acquisition of data, analysis and interpretation of data, and manuscript drafting. HO: conception and design of study, technical help, writing and editing assistance. SH: technical help, writing and editing assistance. HM: technical help, writing and editing assistance. KT: technical help, writing and editing assistance. HH: technical help, writing and editing assistance. SM: technical help, writing and editing assistance. HU: technical help, writing and editing assistance. HK: technical help, writing and editing assistance. SK: technical help, writing and editing assistance. KT: technical help, writing and editing assistance. TK: technical help, writing and editing assistance. YN: technical help, writing and editing assistance. HA: technical help, writing and editing assistance. MA: technical help, writing and editing assistance.

ETHICAL APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance was sought from the medical ethics committee of Tosei General Hospital. Ethical approval was granted after being sought.

DATA AVAILABILITY STATEMENT

All data and material collected during this study are available from the corresponding author upon reasonable request.

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How to cite this article: Sakamoto Y, Osanai H, Hiramatsu S, et al. A case of accessory pathway mapped with ultra-high-resolution mapping led to a coronary sinus diverticulum. *Clin Case Rep*. 2021;9:1315–1320. https://doi.org/10.1002/ccr3.3760