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Case Report

Three-dimensional electroanatomical mapping for atrioventricular nodal reentrant tachycardia associated with persistent left superior vena cava

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A B S T R A C T

Background: The anatomical courses of the slow pathway and His bundle are altered in patients with atrioventricular nodal reentrant tachycardia (AVNRT) associated with persistent left superior vena cava (PLSVC). We report a case of successful catheter ablation in such a patient using an electroanatomical approach with a three-dimensional mapping system.

Case: A 33-year-old woman underwent catheter ablation for AVNRT. The conventional approach for ablating the atrial end of the slow pathway was unsuccessful; therefore, a second attempt was made using a three-dimensional electroanatomical mapping system. The ablation was easily performed without damaging the His bundle because of a clear understanding of the anatomical relationships.

Conclusion: The electroanatomical approach using a three-dimensional mapping system can be an alternative if conventional methods prove to be technically difficult because this new approach can provide precise spatial distribution of the pathways.

1. Introduction

Persistent left superior vena cava (PLSVC) is an anomaly of the systemic venous circulating system and is accompanied by congenital atrioventricular (AV) preexcitation conduction abnormalities. However, its coexistence with atrioventricular nodal reentrant tachycardia (AVNRT) is rarely reported.

In general, catheter radiofrequency (RF) ablation for AVNRT is conventionally performed via an anatomical or electrical approach. An anatomical approach fluoroscopically delivers RF energy to the inferoposterior aspect of Koch's triangle., while an electrical approach explores the potentials associated with the slow pathway. Both strategies are effective in treating the patients with the AVNRT provided there are no anomalies.

However, previous reports have reported the difficulty of RF ablation for AVNRT associated with PLSVC due to an enlargement of the coronary sinus ostium and deviation of the His bundle [1].

In such cases, an electroanatomical approach using a three-dimensional mapping system as described in this case report may be valid and feasible.

2. Case

A 33-year-old woman was referred to the emergency department at our hospital for sustained palpitations lasting more than 6 h.

The electrocardiogram showed narrow QRS complex regular tachycardia, which was terminated by rapid injection of adenosine triphosphate. During the tachycardia, the P wave was not identifiable and was likely hidden completely in the QRS complex (Fig. 1). As the patient desired complete cure of the tachycardia, an electrophysiological study (EPS) was performed.

In the EPS, a 4 French decapolar electrode catheter was easily inserted via the right subclavian vein through the coronary sinus but was not stabilized. The contrast medium injected from the long sheath inserted in the right femoral vein revealed a PLSVC and significantly enlarged coronary sinus (Fig. 2).

The baseline EPS indicated dual AV nodal physiology and V-A conduction via a retrograde fast AV nodal pathway. A narrow QRS complex tachycardia was reproducibly induced and terminated by atrial programmed extrastimulation, and mechanisms other than the slow/fast type AVNRT were excluded.

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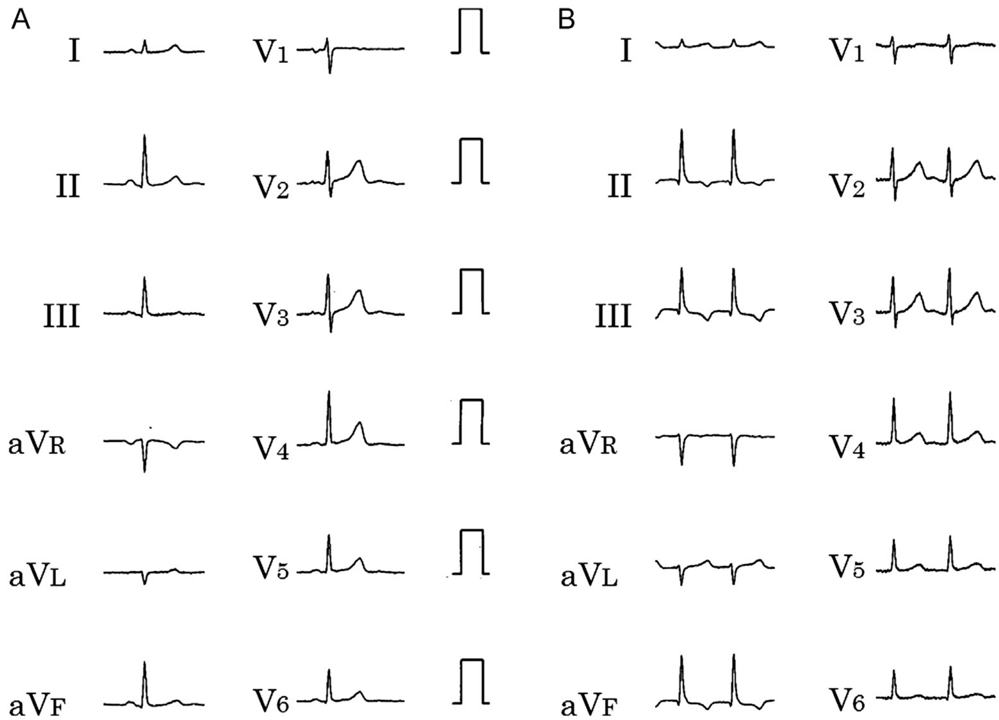

Fig. 1. 12-lead ECG during sinus rhythm and tachycardia. (A) During sinus rhythm. (B) During tachycardia. The QRS complex morphology was similar in both rhythms, but P waves were unidentifiable during tachycardia.

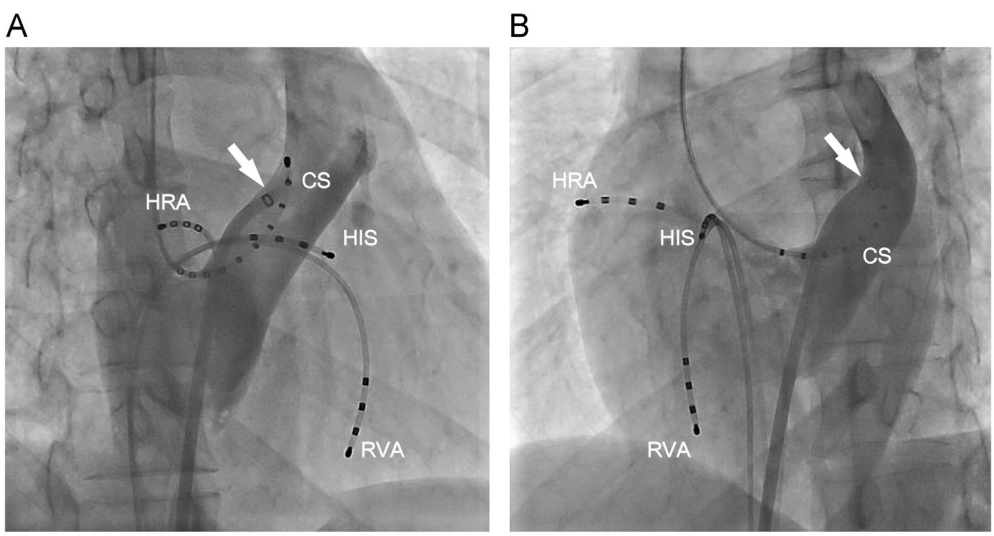

Fig. 2. Coronary venography. Contrast medium injected from the long sheath inserted via the right femoral vein (white arrow) opacified the markedly enlarged coronary sinus as well as the persistent left superior vena cava. A: Right anterior oblique projection. B: Left anterior oblique projection. HRA, high right atrium; CS, coronary sinus; HIS, His bundle; RVA, right ventricular apex.

An appropriate atrial end of slow pathway (Asp) potential was identified at the anterosuperior aspect of the coronary sinus ostium and RF energy was delivered (Fig. 3A and B). The junctional accelerated rhythm was acquired at the eighth time of delivery (maximal temperature: 55 °C; duration: 32 s; power: 30 W). After the ablation, the jump-up phenomenon provoked by the programmed atrial extrastimuli disappeared, and the tachycardia was not inducible at any stimulation before and after isoproterenol administration. Therefore, the ablation was considered successful, and the patient was discharged from the hospital 2 days after the procedure.

However, within a month, the patient complained of recurrent symptoms, and a second session was performed. The positions of electrode catheters were the same as the previous session, while the CARTO system (Biosense-Webster, Irwindale, CA, USA) was used this time. The recurrence of slow pathway conduction was recognized when the atrial programmed stimulation provoked the jump-up phenomenon and induced the slow/fast type AVNRT.

The intracardiac electroanatomical mapping revealed a gigantic coronary sinus ostium and PLSVC (Fig. 4). The upward shift of the His bundle was also observed. The site where the Asp potential was recorded existed at the upper one-third of the enlarged ostium of coronary sinus (Fig. 3C and D and Fig. 4). The distance between the His bundle and Asp site was 14.8 mm. The site was nearly the same as the previous ablation site but slightly more proximal to the His bundle electrode.

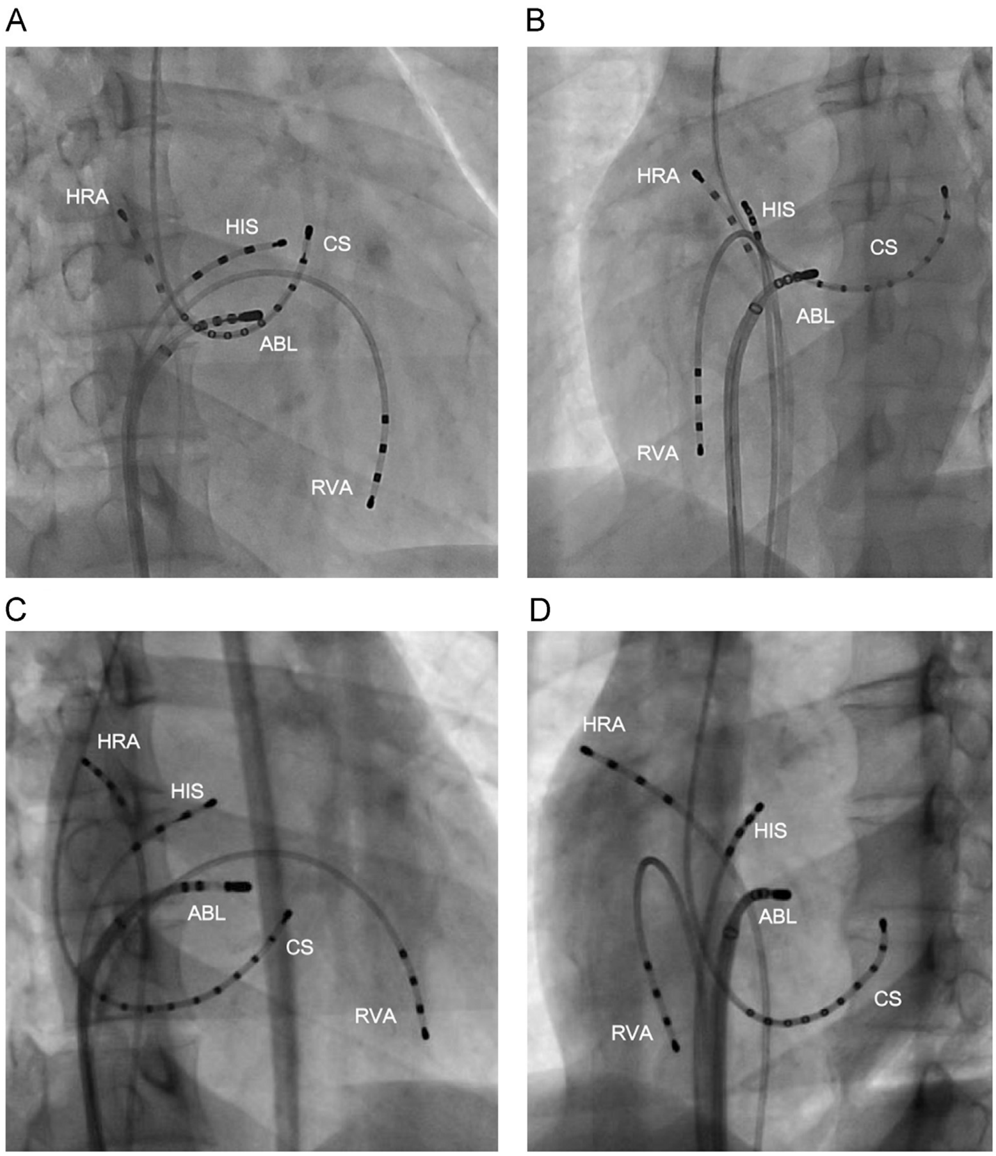

Fig. 3. Fluoroscopic views of catheter ablation of the first and second sessions. Fluoroscopic views in the right anterior oblique projection (A) and left anterior oblique projection (B) show the catheter position. The ablation catheter (ABL) was positioned at the anterosuperior aspect of the coronary sinus ostium, but it was difficult to appreciate given the significantly dilated ostium. Fluoroscopic views in the right anterior oblique projection (C) and left anterior oblique projection (D) in the second session. The ablation catheter was positioned at almost the same place as the first session but was slightly more proximal to the His bundle catheter. HRA, high right atrium; HIS, His bundle; CS, coronary sinus; RVA, right ventricular apex.

The RF energy was delivered without any concerns for damaging the His bundle because the site was adequately distant from the His bundle (Fig. 4). The movement of ablation catheter was easily observed before and during RF delivery by the CARTO system. The accelerated AV junctional rhythm was obtained at the first RF delivery (maximal temperature: 55 °C; duration: 35 s; power: 25 W). The RF energy was delivered again for confirmation (maximal temperature: 55 °C; duration: 47 s; power: 30 W). After the ablation, no jump-up phenomenon was observed, and the AVNRT was no longer inducible at any atrial stimulation even after isoproterenol administration. The patient remained asymptomatic for at least 6 months following the second procedure.

3. Discussion

The coexistence of PLSVC and AVNRT is rare and has only been reported in a few case reports [1–5]. In these few cases, the successful ablation sites varied among the significantly dilated ostia of the coronary sinus.

As Okishige et al. described [1], patients with PLSVC have significantly enlarged coronary sinus ostia, and therefore, the course of the slow pathway may be displaced from its normal alignment. The position of the His bundle may also be displaced, increasing the risk of damaging the AV nodal conduction during an ablation of the atrial end of slow pathway. In this case, RF energy was delivered in the first ablation session for a short duration, as we remained cognizant of the possibility of damaging the His bundle. Moreover, the contact of the ablation catheter to the endocardium may have been insufficient because the anatomical relationship between Koch's triangle and the coronary sinus was difficult to comprehend. Hence, these uncertainties resulted in an unsuccessful ablation.

In contrast, the CARTO system used in the second ablation session could easily identify the coronary sinus, the course of the His bundle, and the atrial end of the slow pathway. The real time monitoring of the position of ablation catheter before and during RF energy delivery

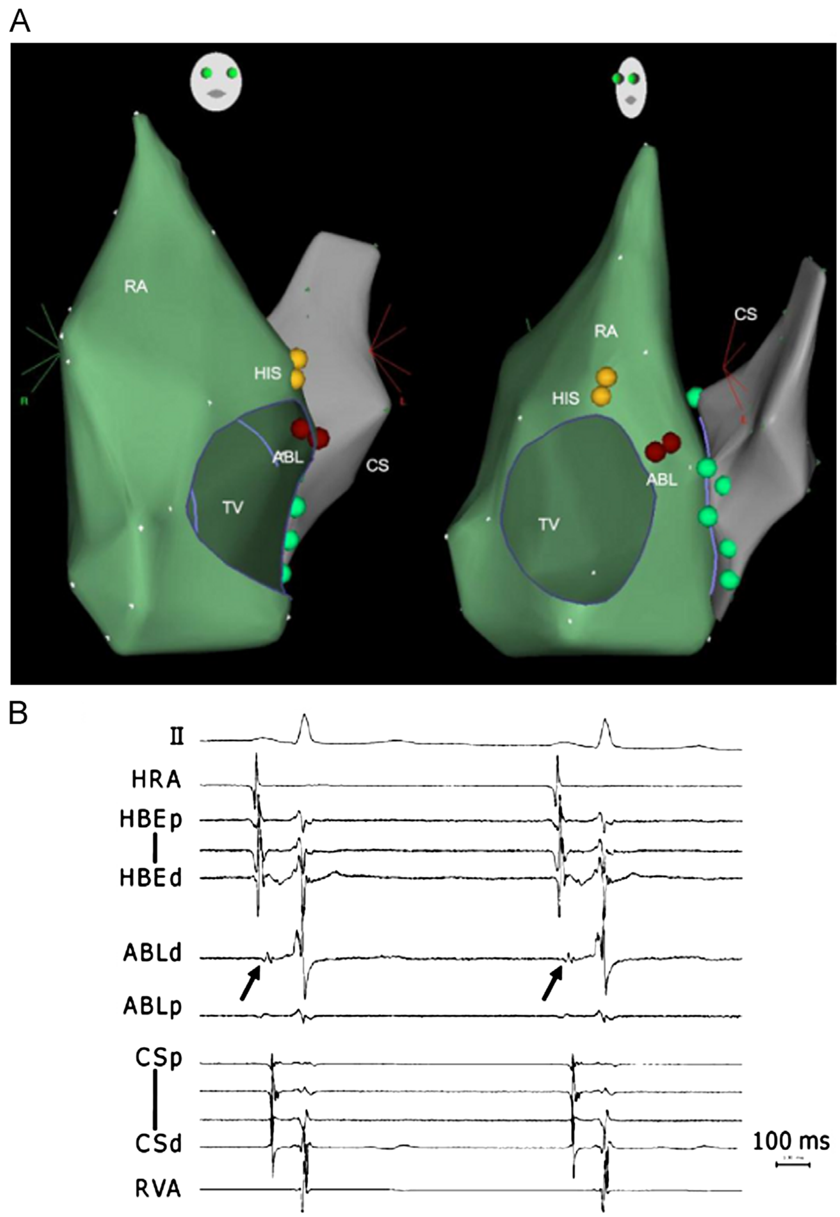

Fig. 4. The catheter ablation with the three-dimensional mapping system. (A)The three-dimensional mapping system revealed a gigantic coronary sinus (CS) ostium and persistent left superior vena cava. The yellow symbols indicate the sites where the His bundle potential were recorded (HIS); the green symbols indicate the ostium of coronary sinus; the red dots indicate the site where the atrial end of slow pathway potential were recorded and the radiofrequency energy was delivered (ABL). Note that the distance between the yellow dots and red dots was 14.8 mm. (B)Slow pathway potential (black arrow) acquired at the site depicted above. HIS, His bundle; CS, coronary sinus; RVA, right ventricular apex; HRA, high right atrium; HBE, His bundle electrode; RA, right atrium; TV, annulus of tricuspid valve.

was also easier using the CARTO system compared to fluoroscopic monitoring. We thus present a case whereby the electrical approach combined with the electroanatomical mapping system was performed safely and effectively.

Conflict of interest

The authors have no conflict of interest to disclose.

Acknowledgments

None.

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