An unusual atrioventricular accessory pathway with an oblique course

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Introduction

Atrioventricular accessory pathways (APs) with oblique courses[1,2] or multiple APs[3,4] are not rare. We report a rare case of AP with an oblique course that comprised dual atrial insertion sites and 1 common ventricular insertion site. This case should be differentiated from dual APs.

Case report

An 18-year-old male patient experienced frequent episodes of palpitations for 6 months. He was referred to our hospital for catheter ablation. This patient had no prior history of structural cardiovascular disease. His chest radiograph and transthoracic echocardiogram showed no abnormalities. The electrocardiogram (ECG) showed Wolff–Parkinson–White syndrome at baseline (Figure 1A) and supraventricular tachycardia (SVT) when symptomatic. A manifest left anterolateral AP was suspected, according to the Arruda algorithm.[5] During electrophysiological study, a 6F decapolar catheter (Biosense Webster, Diamond Bar, CA) was positioned within the coronary sinus (CS) with its proximal electrode pair 9-10 ($CS_{9\text{-}10}$) at CS ostium and distal electrode pair ($CS_{1\text{-}2}$) at lateral mitral annulus (MA), which showed the earliest ventricular activation at electrode pair 5-6 ($CS_{5\text{-}6}$) in sinus rhythm (Figure 2A). Programmed incremental right ventricular apex (RVa) pacing at approximately 500–340 milliseconds revealed eccentric retrograde atrial activation, with the earliest atrial activation at $CS_{1\text{-}2}$ and the second earliest at $CS_{9\text{-}10}$. RVa pacing at 300 milliseconds could repeatedly induce the first orthodromic atrioventricular reentrant tachycardia with the same atrial activation sequence as that observed during RVa pacing (SVT_1, cycle length =280 ms; Figure 2B). Dual AV nodal pathways were excluded by programmed right atrial pacing. The diagnosis of left dual APs was initially considered.

A temperature-controlled ablation catheter (Celsius, Biosense Webster) was inserted for ablation. The earliest activation was targeted for ablation on both the ventricular side and the atrial side through mapping with the ablation catheter if no "isolated" AP potentials could be mapped by the ablation catheter. The catheter was initially positioned on the ventricular side of lateral MA via retrograde aortic route (3-o'clock direction at the left anterior oblique view of MA). Radiofrequency (RF) energy delivery at 30 W and 60°C could impair neither antegrade nor retrograde AP conduction. Consequently, an alternative transseptal approach was applied. The ablation catheter was placed on the corresponding atrial side of the lateral MA after transseptal catheterization via an 8F Swartz sheath (Figure 3A). RF ablation at 40 W and 55°C was able to successfully alter the atrial activation sequence during RVa pacing (Figure 2C). The retrograde A wave became "late" at the lateral MA and remained "early" at the very posterolateral MA, indicating the possible blockade of 1 branch of retrograde AP conduction. However, the antegrade AP conduction remained unchanged, and the second SVT (SVT_2) with the same cycle length (280 ms) as SVT_1 but different atrial activation sequence could still be induced (Figure 2D). At this time, we came to notice the sequential AP potentials on CS recordings during SVT_1 and SVT_2. The earliest AP potential at middle CS conducted simultaneously to distal CS and to proximal CS during SVT_1 (Figure 2E). However, the distal AP potential conduction disappeared during SVT_2 (Figure 2F).

Based on the above findings, we established the diagnosis of an unusual AP with an oblique course, which comprised 2 separate atrial insertion sites and 1 common ventricular insertion site. Subsequently, AP antegrade conduction abolishment was attempted, but failed, by ablation on the ventricular side of the posterolateral MA (4-o'clock direction) (Figures 2G and 3B). Finally, RF ablation on the atrial side of the very posterolateral MA (5-o'clock direction) via a transseptal approach successfully eliminated the other branch of retrograde AP conduction (Figure 3C). Because

KEYWORDS Wolff-Parkinson-White syndrome; supraventricular tachycardia; atrioventricular accessory pathway; oblique course

ABBREVIATIONS ABL = ablation catheter; **AP** = accessory pathway; **CS** = coronary sinus; **ECG** = electrocardiogram; **MA** = mitral annulus; **PAP** = potential of accessory pathway; **RF** = radiofrequency; **RVa** = right ventricular apex; **SVT** = supraventricular tachycardia

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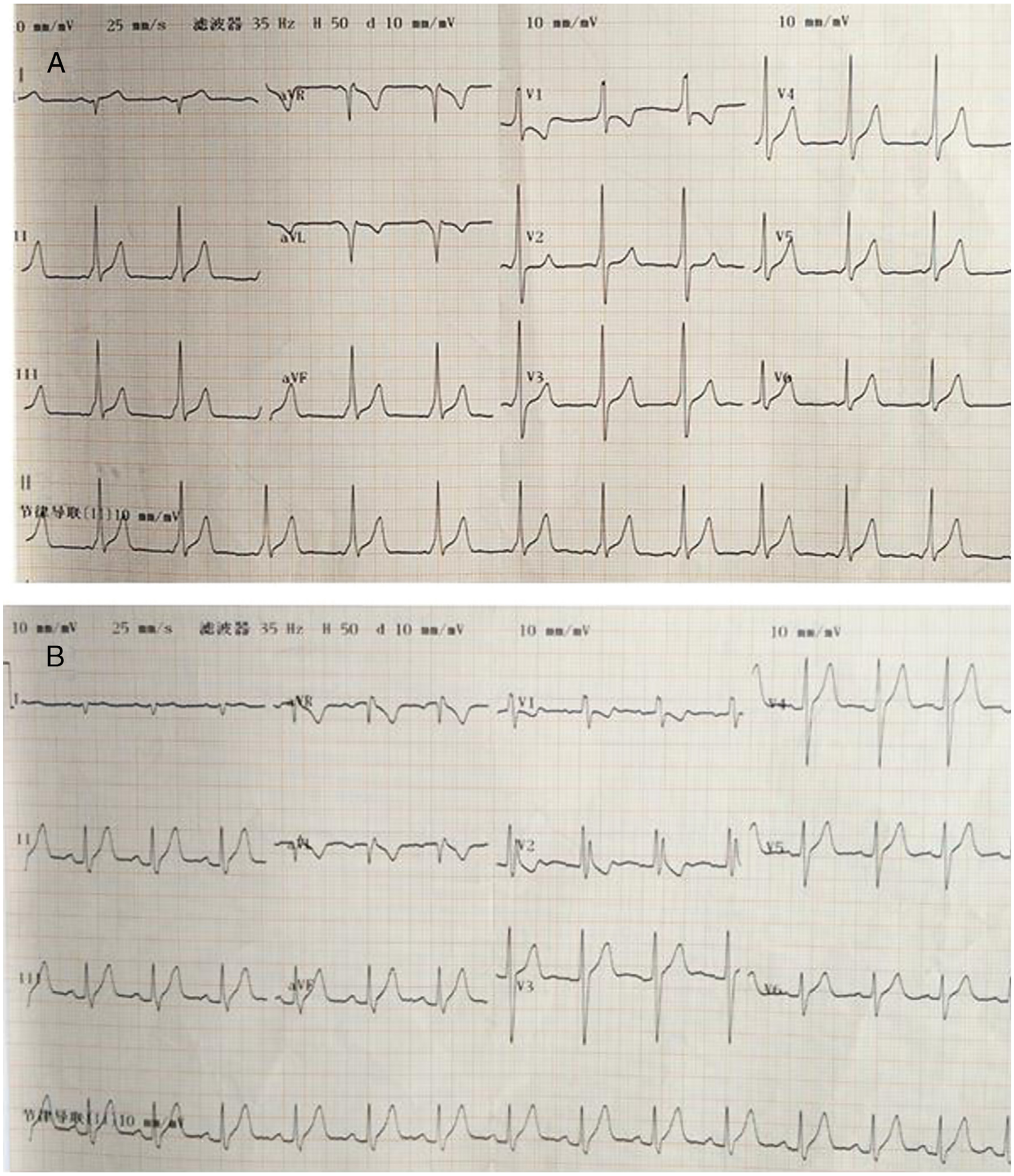

Figure 1 **A**: Wolff-Parkinson-White syndrome prior to ablation; **B**: Disappearance of preexcitation on postprocedural electrocardiogram.

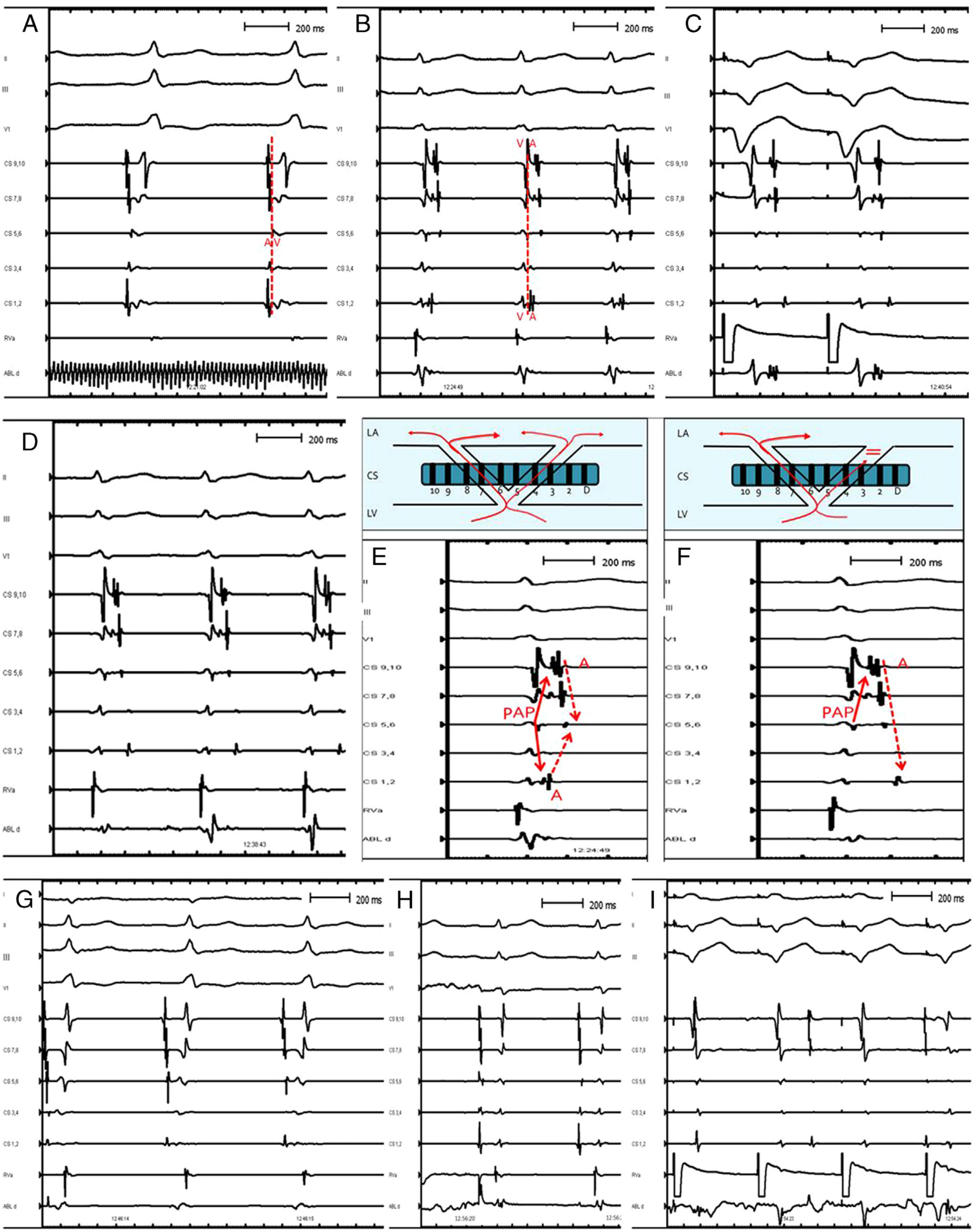

Figure 2 **A**: the earliest ventricular activation at coronary sinus (CS) proximal electrode pair 5-6 ($CS_{5\text{-}6}$) in sinus rhythm. **B**: Supraventricular tachycardia 1 (SVT_1) with the earliest atrial activation at $CS_{1\text{-}2}$ and the second earliest at $CS_{9\text{-}10}$ (dotted line as a caliper). **C**: A retrograde A wave at $CS_{1\text{-}2}$ was markedly delayed during right ventricular apex (RVa) pacing after ablation of 1 atrial end of AP at the lateral mitral annulus (MA). **D**: The atrial activation sequence of supraventricular tachycardia 2 (SVT_2) was similar to that during RVa pacing after ablation of 1 branch of AP. **E and F**: The upper parts of E and F show the schematic diagrams delineating the CS atrial activation sequence during SVT_1 and SVT_2, respectively. The lower parts of E and F show CS recordings of atrial activation during SVT_1 and SVT_2, respectively. In the lower parts of E and F, the solid straight arrow represents conduction sequence of potential of accessory pathways. (PAPs). The dotted straight arrow represents atrial activation sequence. Note the sharp PAP preceding the A wave on each CS tracing and the different atrial activation sequences during SVT_1 and SVT_2. **G**: Persistent preexcitation despite apparent atrioventricular conduction delay on CS recordings. **H**: marked atrioventricular conduction delay and abolishment of preexcitation on ECG. **I**: A complete ventriculoatrial conduction block during RVa pacing after successful ablation of AP.

KEY TEACHING POINTS

- An atrioventricular accessory pathway (AP) can be ascertained to have an oblique course based on the presence of (i) the apparently different location of the earliest atrial and ventricular activation sites (representing atrial and ventricular insertion sites of AP); and (ii) isolated AP potentials on intracardiac recordings during orthodromic atrioventricular reentrant tachycardia.
- The atrioventricular AP with an oblique course in this patient is unusual because it comprises dual atrial insertion sites and 1 common ventricular insertion site in addition to its oblique course.
- An atrioventricular AP with an oblique course can be abolished by ablation of the atrial insertion site (s) or ventricular insertion site if the AP potential cannot be mapped.

1 branch of retrograde conduction had already been blocked, the final ablation successfully eliminated both antegrade and retrograde AP conduction (Figure 2H and 2I). Preexcitation on ECG disappeared (Figure 1B), and there was complete ventricular atrial block by RVa S1S1 pacing at 500 ms. The procedure was free of any complications.

The postprocedural ECG showed no preexcitation, and the patient was discharged 2 days after the procedure. During the follow-up at 6 months, no preexcitation on ECG was detected and the patient was free of palpitation relapse.

Discussion

Most atrioventricular APs (>87%) have been found to have oblique courses.[1] By application of a technique that *reverses the direction of paced ventricular or atrial wavefronts*, an AP is usually diagnosed to have an oblique course based on the prolongation of local VA interval (>15 ms) and the presence of "isolated" AP potentials.[1] In our case, the technique of reversing paced ventricular or atrial wavefronts had not been applied. Despite this, the distinctly different location of the earliest 2 retrograde atrial activation sites and the earliest antegrade ventricular activation site, as well as the "isolated" AP potentials during SVT, could be clearly identified on CS recordings. These findings strongly support the diagnosis of an unusual AP with an oblique course that consisted of dual atrial insertion sites and 1 common ventricular end. Probably one can argue the existence of dual APs with oblique courses. If this is the case here, both of the APs "share" the common ventricular insertion site. Thus, we prefer to define it as an unusual AP with an oblique course, rather than as dual APs.

According to the study of Otomo and his colleagues,[1] the ideal target for ablation of APs with oblique courses is "isolated" AP potentials. However, the true AP potentials can be recorded in only approximately 5%–15% of patients with APs,[6] and, hence, they are less probable to be targeted for ablation in most patients. Consequently, the earliest ventricular or atrial activation is more often targeted for ablation.[7,8] In this case, although the "isolated" AP potentials could be mapped with CS catheters, they could not be clearly recorded by the ablation catheter. Therefore, the earliest ventricular or atrial activation was targeted for AP ablation. Admittedly, because of the limited spatial resolution of the decapolar CS mapping catheter (a duodecapolar catheter is better if possible), ablation of the earliest atrial activation on the atrial or ventricular side of MA is not always successful[7,8]; however, it serves as an effective approach for ablation of APs in most cases.[1] In this patient, ablation of the ventricular end of AP failed, but ablation of dual atrial insertion sites successfully eliminated both antegrade and retrograde conduction of AP.

The ablation of the oblique accessory pathway can be challenging. Overlapping electrograms may produce difficulties in identifying AP potentials. Failure to successfully ablate at the ventricular end in this particular case could be related to epicardial insertion at the ventricular end.

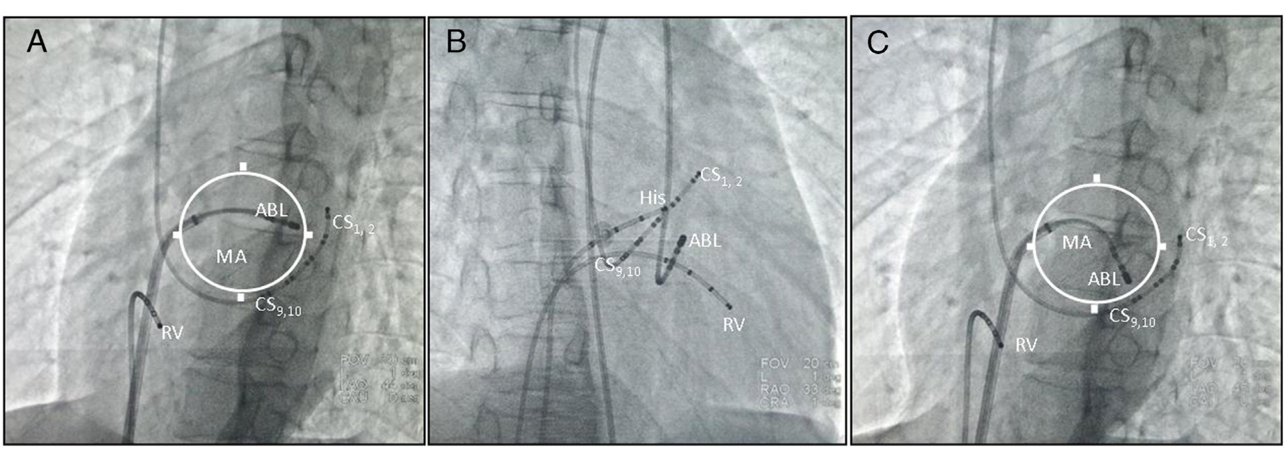

Figure 3 A fluoroscopic image of catheter positioning. **A**: The successful transseptal ablation of 1 branch of AP at lateral MA (left anterior oblique 45° view); **B**: An ablation failure on the ventricular side of the posterolateral MA via transaortic route (right anterior oblique 30° view); **C**: The successful transseptal ablation of the other branch of AP at the very posterolateral MA. The white rings in A and C represent the MA. ABL = ablation catheter; MA = mitral annulus.

Conclusions

An atrioventricular AP sometimes has an oblique course as well as multiple atrial or ventricular insertion sites in unusual cases. Careful analysis of antegrade and retrograde conduction sequence and identification of "isolated" AP potentials during electrophysiological study can facilitate the diagnosis of APs with oblique courses, accurate localization of AP insertion sites, and subsequent RF ablation.

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