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CASE REPORT

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Differential effective refractory period as a useful marker of multiple accessory pathways

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Abstract

Accessory pathway (AP) ablation failure may be related to multiple pathways which go unrecognized at the time of electrophysiology study. We present a patient who had two adjacent APs based on different preexcitation patterns as well as effective refractory periods (ERPs) which have not been previously described. Apart from leading to recurrent supraventricular tachycardia (SVT), multiple pathways are important to recognize as they more frequently predispose to malignant atrial arrhythmias.

KEYWORDS

accessory pathway, atrial fibrillation, ERP, malignant, multiple

1 | CASE REPORT

A 45-year-old healthy woman initially presented with acute onset of right upper quadrant abdominal pain and subjective fever. Physical findings and abdominal ultrasound were consistent with acute cholecystitis and percutaneous drainage of the gall bladder was planned. A routine preprocedure electrocardiogram (EKG) was obtained (Figure 1A) and revealed sinus rhythm with a PR interval of 118 ms with preexcitation. The delta wave was positive in the inferior leads except for lead III, positive in I and aVL, and had an R wave transition at V3 consistent with a midseptal accessory pathway (AP).[1]

On further history, the patient noted 5 episodes of palpitations over the preceding 4 months. Episodes had an abrupt onset, lasted for ten to twenty minutes, and abruptly terminated. The episodes were associated with lightheadedness, but the patient denied syncope. The patient underwent gall bladder drain and ultimately cholecystectomy. Two months later, she was brought to the electrophysiology laboratory. An EKG was repeated prior to testing. This revealed sinus rhythm with preexcitation different than previously noted. The delta wave was positive in all inferior leads, positive in I and aVL, and had an R wave transition at V4. This suggested an AP at a more anterior location (Figure 1B).

After informed consent was obtained, she was referred for electrophysiologic study. Baseline HV interval was 0 ms with manifest preexcitation. During incremental atrial pacing , there was a change in the preexcitation pattern following an atrial premature contraction (Figure S1A). During atrial extrastimuli testing, there was a change in the preexcitation pattern following a premature beat at 400 ms indicating effective refractory period (ERP) of the first AP; with an even more premature beat at 330 ms, the ERP of the second AP was reached (Figure 2A,B). During ventricular extrastimuli testing, change in retrograde atrial conduction also indicated more than one pathway (Figure S1B,C). A short RP tachycardia at a cycle length of 262 ms and VA time of 84 ms was induced with incremental atrial and ventricular pacing (Figure S1D); ventricular overdrive pacing generated a VAHV response and the tachycardia was advanced and reset with His synchronous premature ventricular contractions (PVCs). These findings were consistent with orthodromic reciprocating tachycardia (ORT).

The AP was mapped during sinus rhythm. The earliest ventricular activation was recorded in the anteroseptum; with ablation, there was a change in preexcitation (Figures 2C and 3A). Additional mapping identified early signal along the anterior tricuspid valve annulus (approximately 10 mm from prior ablation site); ablation at this site

Abbreviations: AF, atrial fibrillation; AP, accessory pathway; EKG, electrocardiogram; ERP, effective refractory period; ORT, orthodromic reciprocating tachycardia; PVC, premature ventricular contractions; WPW, Wolff-Parkinson-White.

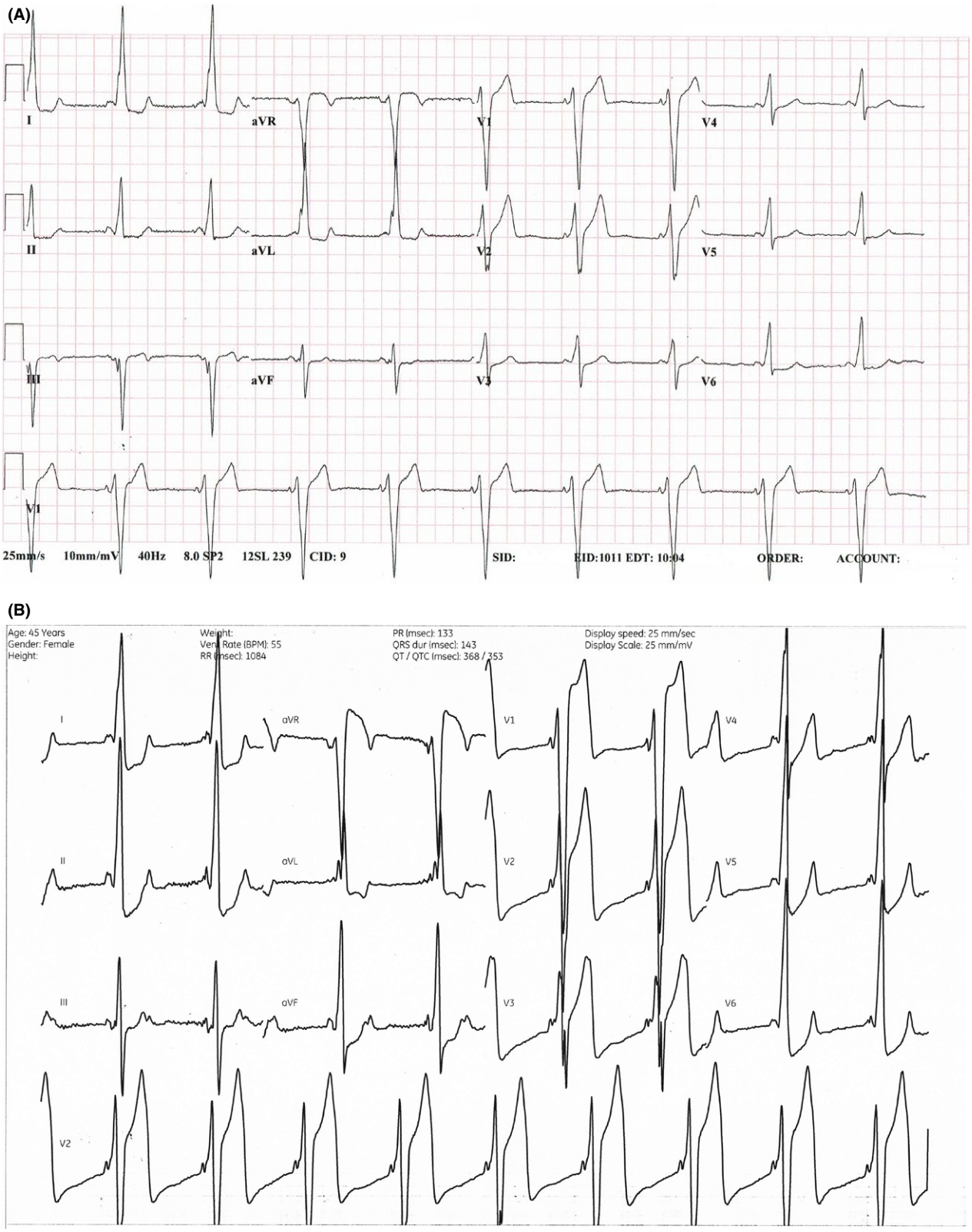

FIGURE 1 Panel A. Surface electrocardiogram (EKG) demonstrating preexcited sinus rhythm on account of the midseptal accessory pathway (AP). Panel B. Surface electrocardiogram (EKG) demonstrating preexcited sinus rhythm on account of the anterior AP

resulted in complete loss of preexcitation (Figure 2D and 3B). There were more obvious changes in the preexcitation pattern upon reaching ERP of the first AP (Figure 2A,B) compared to when the first AP was ablated (Figure 2C) probably on account of more delay and less fusion with atrioventricular (AV) nodal conduction during atrial extrastimuli testing. No return of AP conduction was found during a

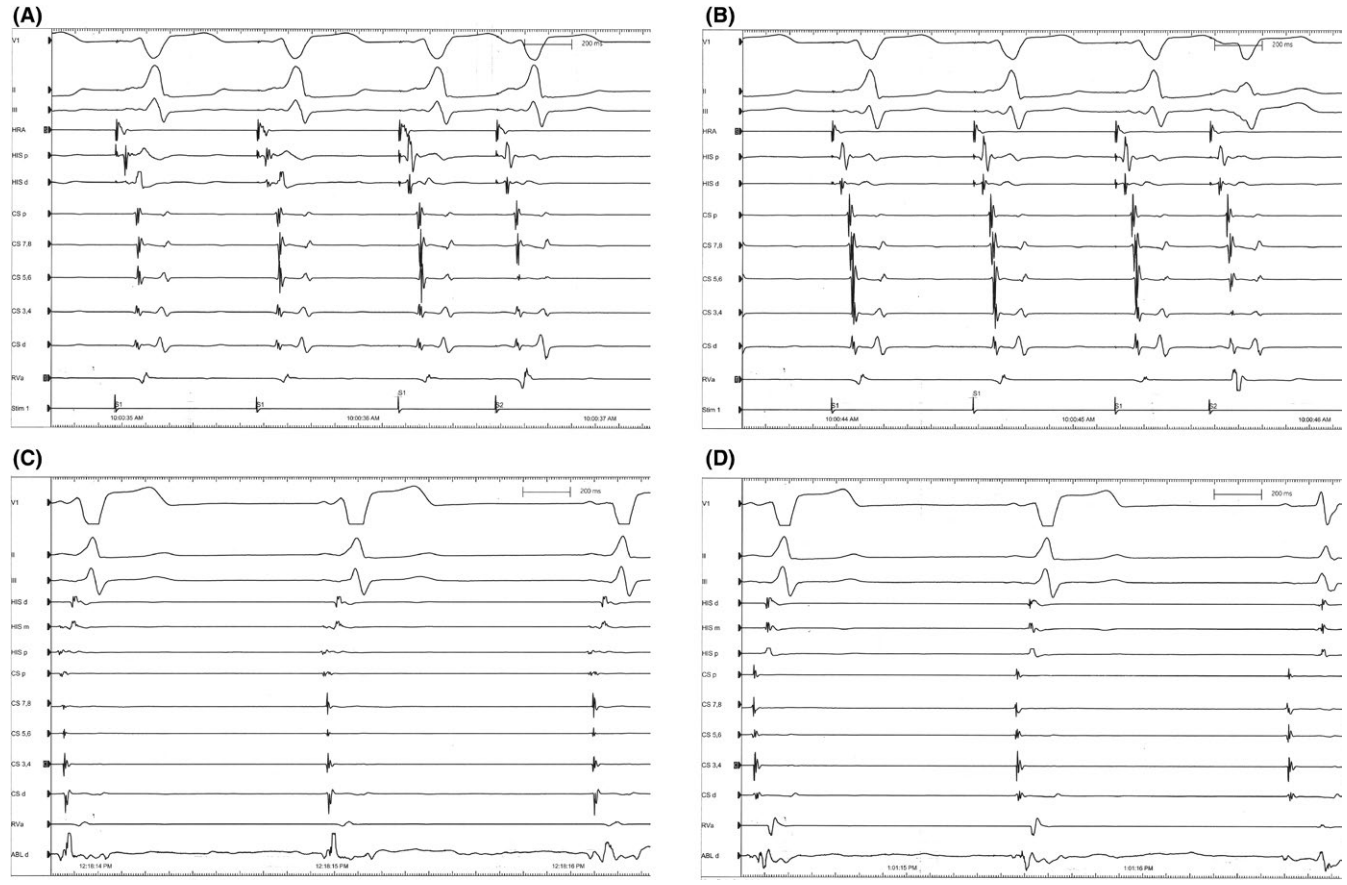

FIGURE 2 Panel A. Ventricular preexcitation on account of accessory pathway 1 with atrial extrastimuli of 400 ms and a 600 ms drivetrain. Panel B. Change in ventricular preexcitation on account of the effective refractory period (ERP) of accessory pathway 1 with atrial extrastimuli of 400 ms and a 600 ms drivetrain. Panel C. Intracardiac signals with change in the preexcitation pattern during ablation of accessory pathway 1. Panel D. Intracardiac signals with change in the preexcitation pattern during ablation of accessory pathway 2

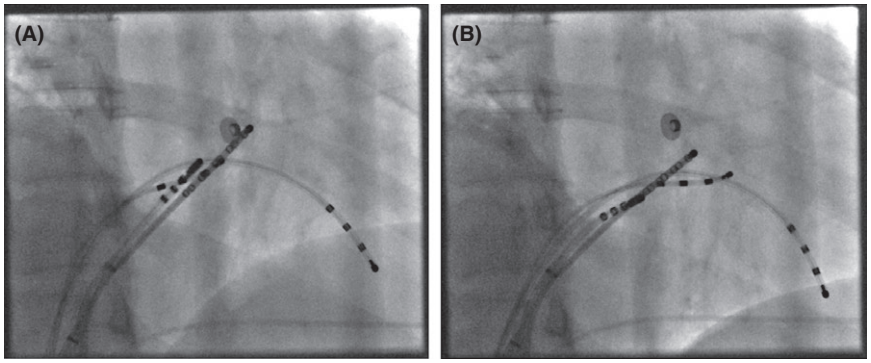

FIGURE 3 Panel A. Fluoroscopic view in right anterior oblique (RAO) projection showing ablation catheter along anteroseptum. Panel B. Fluoroscopic view in right anterior oblique (RAO) projection showing ablation catheter along anterior tricuspid annulus

25 minute waiting period and following isoproterenol infusion. On follow-up, her resting EKG showed no preexcitation.

2 | DISCUSSION

Accessory pathways (APs) separated by 1-3 cm have been defined as being multiple; the most common combination in a case series of 250 patients was right posteroseptal with right free wall bypass tracts.[2] The incidence of multiple APs is 3%-13% and may pose a higher risk of supraventricular tachycardia (SVT), antidromic reentry, more rapid conduction during atrial fibrillation (AF), and ventricular fibrillation.[3]

Multiple APs may be identified during electrophysiologic study by (a) different patterns of preexcitation during atrial pacing or atrial fibrillation (AF) with varying delta wave morphology of ventricular activation; (b) different sites of atrial activation during ventricular pacing or orthodromic reciprocating tachycardia (ORT); (c) preexcited tachycardia using a second pathway as the retrograde limb of the circuit; (d) mismatch between atrial and ventricular ends of

the AP when comparing antidromic and orthodromic reciprocating tachycardia; and (e) change from orthodromic to antidromic reciprocating tachycardia or vice versa.[4]

The reported success rate for the ablation of multiple AP is 86%-98%.[4] Failure to recognize the presence of more than one pathway is cited as a reason for the acute failure of ablation. In a case series of 89 patients who had previously undergone failed Wolff-Parkinson-White (WPW) ablation, multiple or large APs were seen in 13 patients.[5] In our patient, the identification of dual APs was demonstrated by distinct ERPs as well as a change in the preexcitation pattern with successful ablation of the first AP. As far as we know, differential ERPs from adjacent APs have not been described in the literature and is a useful marker for the identification of multiple APs. Being vigilant of changes in ventricular preexcitation during atrial extrastimuli testing may allow for early recognition of multiple pathways and increase ablation success rate.

Fusion caused by enhanced AV nodal conduction and changes in adrenergic tone may affect the accessory pathway ERP resulting in the appearance of multiple pathways. This was unlikely in our case for several reasons. First, the ERPs were determined consecutively so there was no change in the heart rate or adrenergic tone. Second, since accessory pathway ERPs may be sensitive to isoproterenol, those in our study were determined prior to isoproterenol administration. Third, the QRS morphology in Figure 2B following ERP of the first pathway was still very preexcited and negative in V1 and III. If more AV nodal conduction was occurring, we would expect it to more closely resemble the QRS morphology following ablation of the both pathways (Figure 2D), which was more biphasic in V1 and III.

Patients with WPW are at increased risk for atrial arrhythmias; a two-dimensional computer model by Schwieler et al. demonstrated that reflection along a linear AP and/or microreentry at a branched AP-ventricle junction can promote AF.[6] Because they predispose to more rapid AF, it is critical that multiple pathways are evaluated for during electrophysiology study and ablated if present. We propose that even if SVT is not inducible after ablation of one pathway, any other pathways should be ablated because of this elevated risk of malignant arrhythmias.

3 | CONCLUSIONS

Multiple APs present diagnostic and therapeutic challenges. Differential ERP of adjacent APs has not been described and is a useful tool during electrophysiologic study. Those with multiple APs have a higher incidence of malignant arrhythmias, making recognition and treatment particularly important.

CONFLICT OF INTEREST

The authors declare no conflict of interest for this article.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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