

Open-window mapping of atriofascicular tachycardia



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Introduction

Accessory atrioventricular pathway (AP) conduction is found in 33% of patients with Ebstein anomaly, including atriofascicular (AF) pathways in 5%–8%.¹ AF pathways typically conduct anterograde only, with decremental conduction properties analogous to the atrioventricular node (AVN), and participate almost exclusively in antidromic atrioventricular reciprocating tachycardia (AVRT).^{1,2} Ablation of AF APs may be challenging in such patients due to the deviation from normal anatomic structure, potential for multiple APs, difficulty obtaining catheter stability, hemodynamic instability in tachycardia, and concerns for catheter-induced mechanical conduction block. There also is interpatient variation of the insertion sites of AF pathways into the right ventricle (RV) and right bundle branch. High-density mapping may afford an efficient and precise means for mapping and ablation of AF pathways in individuals with Ebstein anomaly.

A previous report of high-density mapping of an AF tachycardia described arborization of the AF fiber in the distal, lateral RV.³ In that case, successful ablation was performed at the atrial insertion, near the tricuspid annulus (TA). Here we present the use of high-density mapping to identify a successful site of ablation near the ventricular insertion site of the AF fiber during AVRT.

Case report

A patient with Ebstein anomaly and atrial septal defect repair was evaluated in clinic for recurrent palpitations. An ambulatory event monitor revealed several episodes of paroxysmal wide-complex tachycardia. During sustained runs, the QRS morphology was at its widest. During nonsustained runs,

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KEY TEACHING POINTS

- Open-window mapping with a high-density catheter is an efficient method to map atriofascicular tachycardia and may elucidate the optimal site of atriofascicular pathway ablation.
- Atriofascicular potentials may be present at the annulus and/or the distal/lateral right ventricular free wall. If no atriofascicular potentials are observed near the annulus, successful ablation can be performed at the distal insertion of the atriofascicular pathway.
- High-density mapping during atriofascicular tachycardia may help to understand and recognize this infrequently encountered arrhythmia.

there was variation in the width of the QRS. Baseline 12-lead electrocardiogram showed a short PR interval, intraventricular conduction delay with a left bundle branch block–like pattern, and rS morphology in lead III (Figure 1A). Of note, this latter characteristic is known to be present in ~60% of patients with AF pathways compared to only 6% in the normal population.⁴

After providing informed consent, the patient agreed to electrophysiological study and ablation. Electrophysiological study demonstrated concentric and decremental VA conduction utilizing the AVN, as well as anterograde conduction consistent with an AF pathway. During sinus rhythm, the AH interval was normal, with an HV interval of 23 ms. Tachycardia was easily inducible with atrial burst pacing. The tachycardia cycle length was 360 ms, and the QRS had a left bundle branch block pattern with a V₆ transition, identical to that seen with maximal pre-excitation during atrial pacing (Figure 1B). Reversal of His-bundle conduction was observed during tachycardia, as well as during programmed stimulation with maximal pre-excitation. Atrial activation was concentric. Attempts to advance the ventricle with programmed atrial stimulation while the septal atrium was committed resulted in induction of atrial flutter and atrial

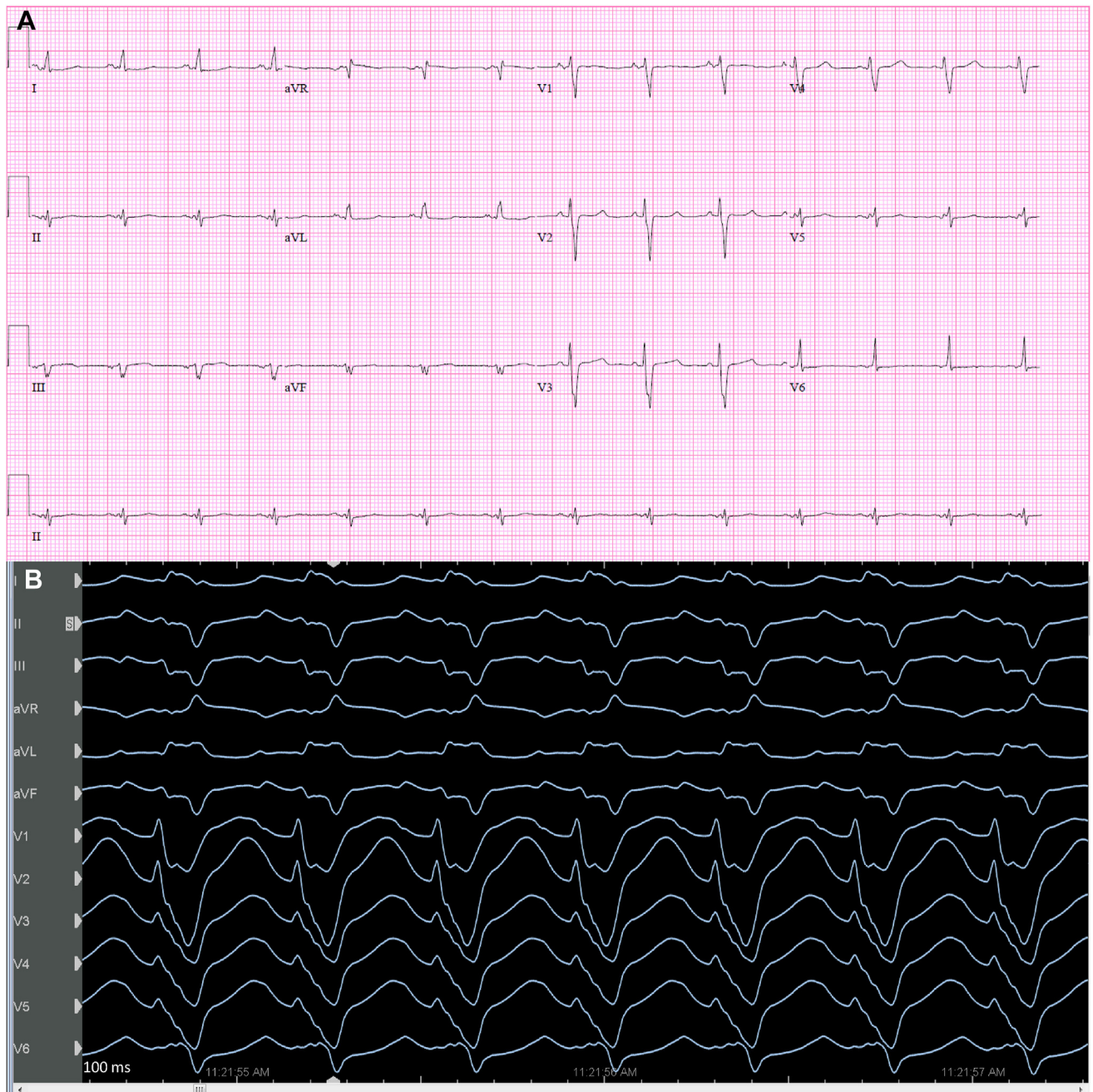


Figure 1 A: Baseline 12-lead electrocardiogram (ECG). B: Twelve-lead ECG of the clinical tachycardia. Time scale is 100 ms per tick mark.

tachycardias that were hemodynamically poorly tolerated. Spontaneous premature atrial contractions did advance subsequent ventricular activation with the same QRS morphology as the clinical tachycardia; however, it was unclear whether the septal atrium was committed. Given the response to premature atrial stimuli, open-window mapping of the tachycardia was performed to define the propagation of the tachycardia. AF tract potentials (Figure 2A) were observed starting about 2 cm from the lateral TA and continued to the earliest ventricular activation site (Figure 2B). Apical displacement of only the septal leaflet of the tricuspid valve was evident in the septal retrograde

activation pattern. During sinus rhythm, pacing at the distal AF pathway insertion site generated a QRS morphology identical to that during the clinical tachycardia.

Open-window mapping during tachycardia with the EnSite Advisor HD Grid Catheter (Abbott Laboratories, Abbott Park, IL) and EnSite™ X EP System (Abbott Laboratories) revealed antidromic AVRT, with the earliest ventricular activation at the distal, lateral RV (Figure 2B). There were discrete sites of equally presystolic potentials in the distal/lateral RV consistent with previous observations of AF arborization into the ventricle.³ Open-window local activation timing mapping was performed using absolute dV/dT

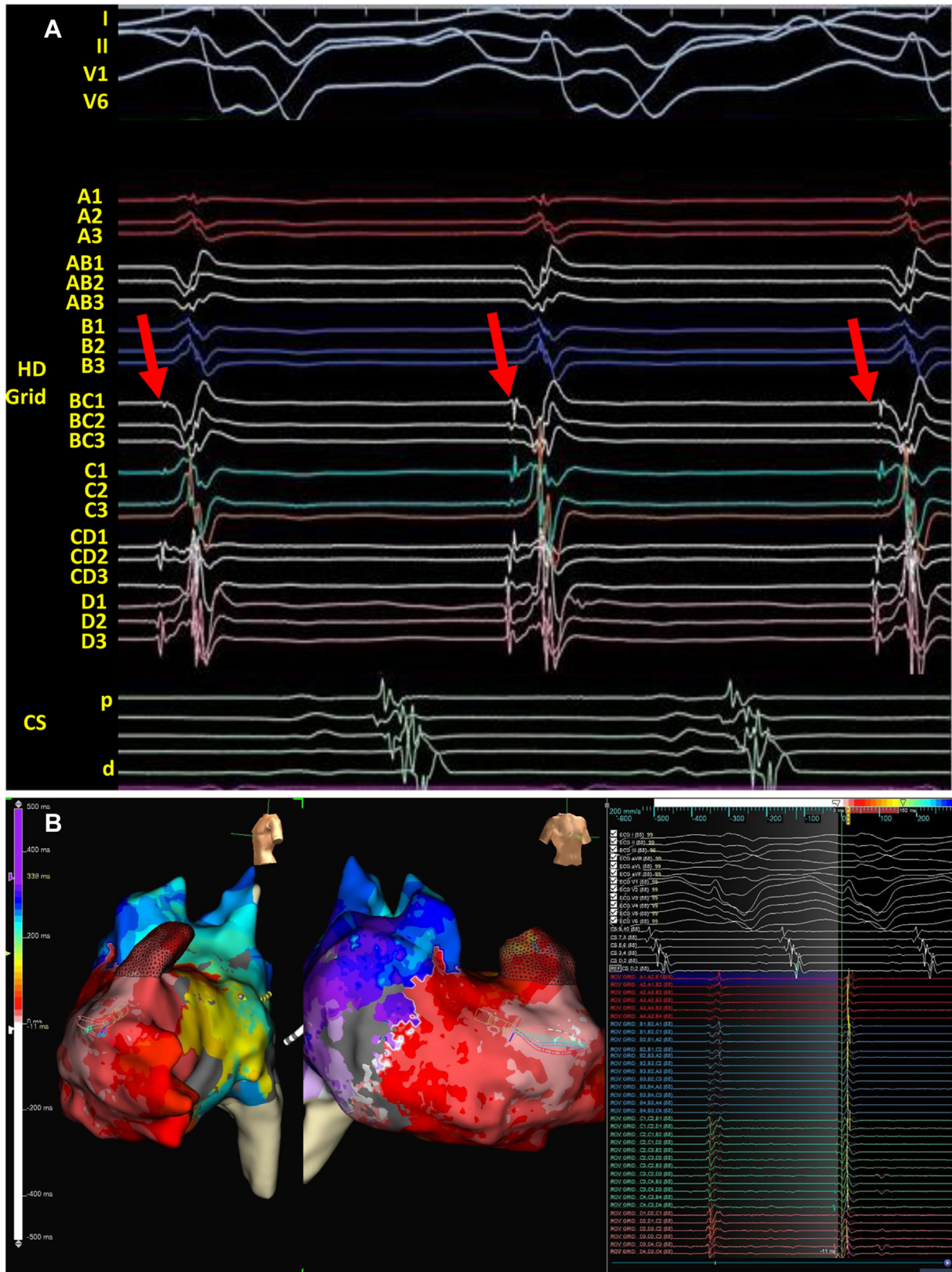


Figure 2 **A:** Atriofascicular potentials (red arrows) along the distal, lateral right ventricle during tachycardia. HD grid electrograms (from top to bottom) are A1-A3, AB1-AB3, B1-B3, BC1-BC3, C1-C3, CD1-CD3, and D1-D3. Two-letter, one-number electrograms represent bipoles from 2 adjacent HD grid electrodes. AB1 represents a bipole between A1 and B1. CS electrograms (from top to bottom) are proximal to distal. **B, left:** Left anterior oblique and right anterior oblique local activation timing maps of the clinical tachycardia. Color scale of the activation map is shown (left), with white representing electrograms that precede onset of the QRS. **B, right:** Electrograms from the HD grid at the area of earliest ventricular activation.

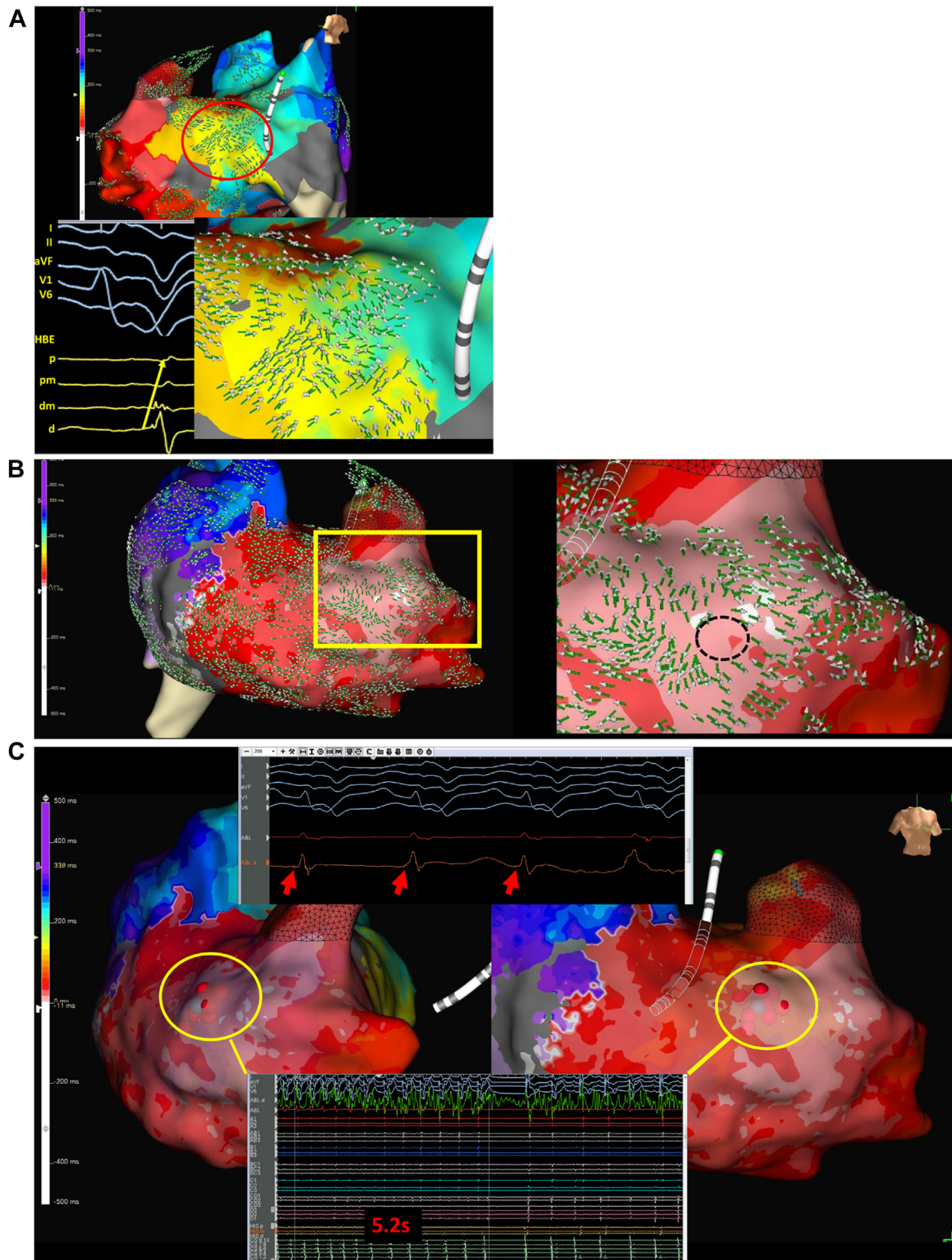


Figure 3 A: Left lateral view with EnSite Omnipolar Technology (OT) showing retrograde septal activation progressing up the right ventricular (RV) septum and through the right bundle branch to the atrioventricular (AV) node. **Lower left:** His catheter, with recordings. *Yellow arrow* shows retrograde His-bundle activation, consistent with the diagnosis of AV reciprocating tachycardia. **Lower right:** Retrograde activation with OT vectors in the area of the His bundle and AV node. **B, left:** Right anterior oblique view with EnSite OT vectors showing earliest ventricular activation along the distal, lateral RV. **B, right:** Close-up of the earliest area of ventricular activation (*yellow box*) showing several areas of early ventricular activation (*white*) consistent with arborization of the distal fascicle as it inserts into the ventricle. *Dashed circle* shows radial spread of local activation, annotated by omnipolar vectors, away from an area near the earliest ventricular activation. **C:** Successful ablation during tachycardia at a site just basal to the site of earliest ventricular activation (*blue dot* within *yellow circle*) after 5.2 seconds of ablation. **Top:** Electrogram on the ablation catheter at the initial and effective lesion. Note the fascicular potential (*red arrows*) and presystolic ventricular electrogram at the effective site of termination.

detection, and points were manually reviewed to ensure the fidelity of ventricular activation annotation. Following activation of the atrium at the lateral TA, there was a brief pause, before the earliest ventricular activation, which occurred at the distal, lateral RV (Supplemental Videos 1 and 2). Ventricular conduction then propagated posteriorly toward the lateral TA, as well as around the remainder of the apical and septal walls. Along the ventricular septum, activation coursed toward the basal septum and retrograde via the AVN to the septal atrium (Figure 3A). Right atrial activation was septal to lateral to complete the circuit.

Given the inability to locate the atrial insertion of the AF pathway or to identify AF potentials near the TA, the area of earliest ventricular activation site was targeted. Ablation was successfully performed during tachycardia at a site just basal to the area of earliest ventricular activation, which was identified using open-window mapping (Figure 3B). The ablation catheter recorded an AF potential as well as a presystolic ventricular electrogram at the initial and effective site of ablation. After termination of tachycardia (Figure 3C), the subsequent electrocardiogram showed sinus rhythm with a normal PR interval of 180 ms and right bundle branch block morphology (Supplemental Figure 1). AH and HV intervals were 80 ms and 44 ms, respectively. After ablation, tachycardia was non-inducible despite multiple attempts using burst pacing and programmed stimulation. Anterograde AF conduction was no longer demonstrable with atrial programmed stimulation.

Discussion

This case demonstrates the efficient utility of high-density electroanatomic mapping of AF pathways during antidromic AVRT in a patient with Ebstein anomaly. Previous studies have demonstrated effective ablation at the TA when AF potentials can be identified at that location. However, when AF tract potentials are not identified at the TA, an alternative ablation strategy involves ablation of the distal insertion site, with success rates dependent on identification of AF potentials.⁵ Ablation at the ventricular insertion site is challenging given the reported arborization of the distal AF pathway. Previous reports have described change in pre-excitation pattern without eliminating tachycardia following ablation at the distal insertion site.^{6,7} In our case, termination of tachycardia and successful anterograde AF block were

achieved by limited ablation near the distal insertion site of the AF pathway, which was identified with high-density, open-window mapping. Similar to previous observations, ablation at the site of earliest ventricular activation unmasked right bundle branch block when ventricular pre-excitation was lost.⁷ Utilization of open-window, high-density mapping facilitated visualization of the AF pathway insertion as well as the tachycardia circuit in a timely fashion in our patient.

Conclusion

The AF AVRT circuit can be visualized using open-window, high-density mapping, which may be useful to understand and successfully treat this infrequently encountered arrhythmia. Ablation near the distal insertion site of the AF fiber into the distal RV is an alternative option when AF potentials are not visualized at the TA.

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Appendix Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2022.08.011>.

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