A single Mahaim accessory pathway with bidirectional delta waves

Chun-Chao Chen, MD,* Yu-Feng Hu, MD,† Shih-Ann Chen, MD†

*From the *Division of Cardiology, Department of Internal Medicine, Shuang Ho Hospital, Taipei Medical University, New Taipei City, Taiwan, and †Heart Rhythm Center, Division of Cardiology, Department of Medicine, Taipei Veterans General Hospital, Taipei, Taiwan.*

Introduction

The changing morphologies of preexcited QRS complexes involving atriofascicular pathways have been poorly characterized, a phenomenon that might be related to variable distal insertions of right atriofascicular pathways or the conduction pattern of the bundle branch system.[1–3] We present a patient with right atriofascicular pathway and changes in preexcitation QRS morphology during right bundle branch (RB) block.

Case report

A 39-year-old man had manifest preexcitation with delta waves with inferior axis during sinus rhythm and a decrementally conducting accessory pathway (AP) without retrograde conduction. Only atrial fibrillation with preexcitation was inducible. During atrial burst pacing of 500 ms, the axis of the delta waves became superior (lead aVF), and an R wave was observed in V_1 (Figure 1A). Atrial burst pacing induced progressive prolongation of the AP-RB interval (from fusion to 42 ms), which was associated with axis change for the delta waves and the appearance of the aforementioned R wave on V_1 (Figure 1B). Pacing at a shorter interval of 380 ms induced RB block (as indicated by a qR pattern on V_1) and maximal preexcitation with prominent delta waves with superior axis at an interval of 330 ms (Figure 2A). Preexcitation was eliminated by ablation of the right posteroseptal AP, and no additional APs could be identified. The conduction pattern of the bundle branch system was suspected to be the mechanism underlying the observed manifestations (Figure 2B and C). Although the AP preferentially conducted through the RB during sinus rhythm (producing the delta waves with inferior axis), conduction delay between the AP and the RB after burst atrial pacing prevented RB conduction by the AP. Instead, the AP activated the right ventricle, producing the manifestations of delta waves with superior axis.

KEY TEACHING POINTS

- An accessory pathway with a characteristic of antegrade decremental conduction (Mahaim fiber) may have different QRS morphology while right bundle branch block was induced by performing atrial pacing.
- The distal insertion site of the Mahaim fiber and the conduction pattern of the bundle branch system could be the mechanism for the bidirectional delta waves.
- Both surface electrocardiography and intracardiac electrograms were crucial for accurate diagnosis of the origin and distal insertion site of a Mahaim fiber.

Discussion

We present a case involving an alteration in delta waves (from inferior to superior) and a QRS configuration change (a leftward shift) with RB block (as indicated by a qR pattern on V_1) during atrial rapid pacing in a patient with a right posteroseptal Mahaim AP. Changes in QRS configuration have rarely been reported for Mahaim APs. Haïssaguerre and colleagues[1] reported that Mahaim APs could be classified as atrioventricular fibers and atriofascicular fibers based on their sites of distal insertion. In 41% of patients, Mahaim APs appeared to not be directly connected to the RB system, as evidenced by the absence of His-Purkinje potentials ahead of non-preexcited QRS complexes and a

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Address reprint requests and correspondence: Dr Yu-Feng Hu, Heart Rhythm Center, Division of Cardiology, Department of Medicine, Taipei Veterans General Hospital, No 201, Sec 2, Shih-Pai Rd, Taipei, Taiwan. E-mail address: huhuhu0609@gmail.com.

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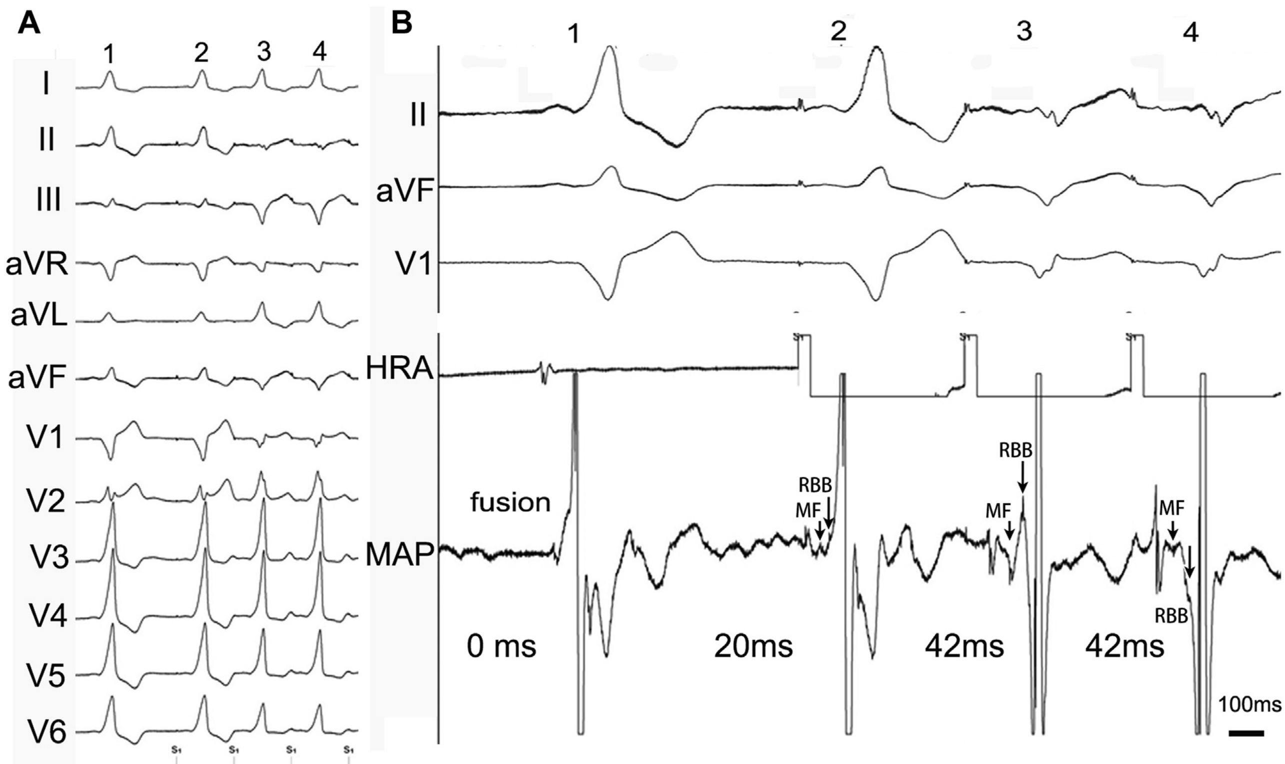

Figure 1 Changes in the delta axis during atrial burst pacing. **A:** Twelve-lead electrocardiography showed changes in the delta axis from inferior axis to superior axis during burst pacing from the high right atrium. **B:** An intracardiac electrogram demonstrated the progressive prolongation of intervals between the Mahaim fiber (MF) and the right bundle branch (RBB) from fusion to 42 ms, indicating RBB block.

significant delay of 22 ms in retrograde activation of the RB.[1] Sternick and colleagues[2] first reported 2 patients with atriofascicular APs with changes in tachycardia cycle length during antidromic atrioventricular reentrant trachycardia (AVRT) and axis change in QRS configuration. The insertion sites of these APs were thought to be near or in the RB, and the presence of retrograde RB block caused the alteration of right ventricular activation as well as changes in the QRS axis and the tachycardia cycle length.[2] Gandhavadi and colleagues[3] further proposed a more comprehensive mechanism in which the moderator band acts as the interconnection between a Mahaim AP, the right ventricular free wall, and the Purkinje septal fibers–RB. During short V-H AVRT, there is preferential conduction over the retrograde RB and left anterior fascicle (LAF) to produce a fused QRS morphology with a normal axis. During long V-H AVRT, the retrograde RB block prevents conduction over the LAF. The activation of both ventricles via only the right ventricular free wall leads to leftward shift of the QRS axis.[3] The change in the QRS frontal axis observed in the present case could be explained in a similar manner. The manifestation of RB block (the prolonging of the AP-RB interval from fusion to 42 ms) prevented retrograde RB-LAF conduction of the Mahaim AP, leading instead to activation of the regional myocardium, and changed the frontal axis of the QRS morphology. However, it is possible that the insertion of AP at the RV septal base would activate both the proximal RB and nearby myocardium without the involvement of the moderator band. Furthermore, the prolongation of the AP-RB interval could also be explained by the delayed activation of the RB, which led to the preferential conduction via AP–moderator band toward the free wall, and changed the axis of the QRS morphology.

Most of the atriofascicular APs (more than 95%) are located at the posterior or free wall of the tricuspid annulus, and therefore, precordial transition usually occurs at lead V_4 to V_5.[4,5] In the present report, the AP was located at the posteroseptal area, a rare location. The electrocardiograms have been characterized by early precordial transition at lead V_2 owing to the earliest activation on the septal base of the ventricle in atrioventricular septal or fasciculoventricular APs, which probably explains the electrocardiogram pattern of the present report. The early precordial transition at lead V_2 in an atriofascicular pathway was similarly reported by Sternick.[6]

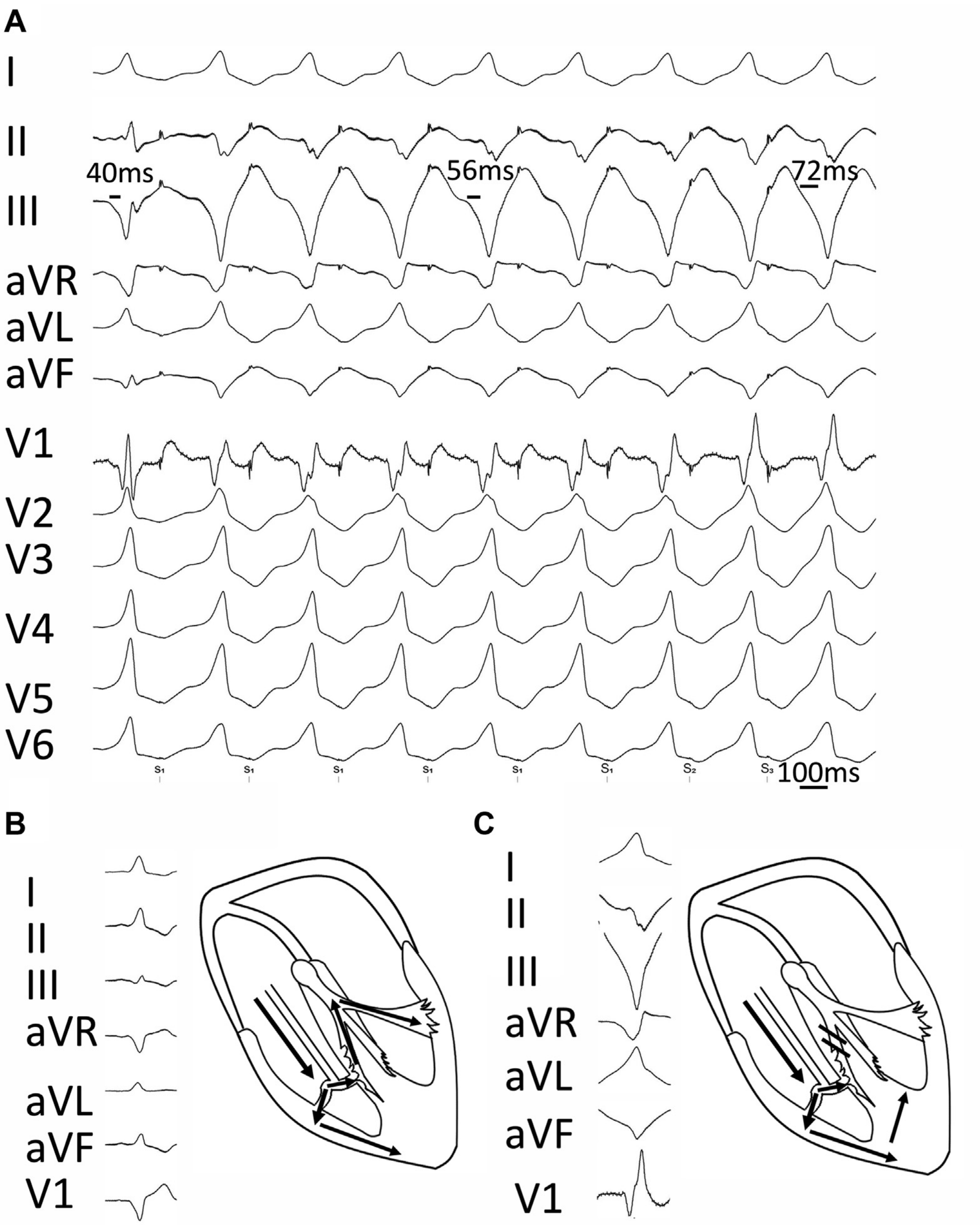

Figure 2 Changes in retrograde conduction during right bundle branch (RB) block. **A:** The progression of RB block, as demonstrated by an increased R wave on V_1, was associated with increased duration of delta waves with superior axis. **B:** Without RB block, the Mahaim accessory pathway was conducted through the moderator band and then the RB. The left ventricle was mostly activated via antegrade conduction of the left bundle branch, leading to delta waves with inferior axis. **C:** RB block prevented retrograde conduction through the RB. Regional activation of the moderator band and right ventricle and transseptal activation of the left ventricle apex led to the manifestation of delta waves with superior axis.

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