Bundle branch reentry with His dissociation—The His bundle: Bystander or participant?

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Introduction

Bundle branch reentry (BBR) is a unique form of ventricular tachycardia (VT) that is mostly seen in patients with underlying conduction disease.

Though dependent on bundle branch conduction disease, BBR connection to His bundle conduction disease and the His bundle contribution to the circuit remains poorly understood.

Case report

A 60-year-old man who has history of paroxysmal atrial fibrillation and right bundle branch block (RBBB), QRS = 160 ms, was referred for evaluation of sustained wide complex tachycardia (WCT), with a similar RBBB morphology, that terminated with adenosine. On electrophysiology study, he was noted to have HV = 95 ms, and on Isuprel, right ventricular (RV) burst pacing, induced WCT with a left bundle branch block (LBBB) morphology, cycle length = 460 ms, and a stable right bundle potential–QRS interval = 28 ms (Figure 1A). The atrial and His electrograms at cycle length of 495 ms (sinus tachycardia) were initially dissociated, then converted to retrograde activation pattern, with a consistent HV interval = 220 ms (Figure 1B).

The response to spontaneous late premature ventricular contractions (PVCs) and His extrasystole are seen in Figure 1C and D.

Entrainment by RV pacing was not possible, as it terminated the tachycardia consistently, whereas concealed entrainment was observed with atrial pacing (Figure 2A).

Diagnosis

The differential diagnosis for the presented WCT includes supraventricular tachycardia (SVT) with LBBB aberrancy vs VT. SVTs that can present with faster ventricular than atrial rates are rare and include atrioventricular nodal reentry tachycardia (AVNRT) with upper common pathway block, orthodromic as well as antidromic atrioventricular reentrant tachycardia via a nodofascicular pathway, junctional tachycardia, and intra-Hisian reentry. In this patient, the dissociated faster ventricular rates from the His-atrial rates argues for VT. Other findings that do not support SVT include retrograde His activation, which excludes AVNRT and orthodromic atrioventricular reentrant tachycardia, and the termination with late PVCs, which excludes AVNRT, junctional tachycardia, and intra-Hisian reentry. The differential diagnosis for LBBB morphology VT with right bundle (RB), QRS interval = 28 ms, includes BBR, vs RB fascicular VT[1] and intramyocardial reentry VT (MVT)[2] exiting via the RB with retrograde His activation, which becomes possible at the longest VA (sinus) interval (retrograde His conduction preempts antegrade activation). The abnormal baseline HV = 95 ms, the tachycardia HV interval > baseline HV, and the response to RV apical PVCs that terminate VT with infranodal retrograde conduction block all favor BBR, but do not exclude other types of VT that can occur in patients with infranodal conduction disease and terminate by late PVCs with retrograde infranodal block, owing to long–short V-V sequence. Entrainment maneuvers for BBR[3] in this patient were limited, and RV pacing terminated VT,

KEY TEACHING POINTS

- Intra-Hisian conduction disease can result in transient His dissociation from ventricular electrograms during bundle branch reentry that could be mistaken for other types of ventricular tachycardia.
- Longitudinal dissociation owing to intra-Hisian conduction disease can play a role in the development of bundle branch reentry and its progression.
- Autoimmune myocarditis can present with incessant bundle branch reentry, and can be treated successfully with immunosuppressive medications.

KEYWORDS Bundle branch reentry; Conduction system disease; His bundle disease; Longitudinal dissociation; Ventricular tachycardia
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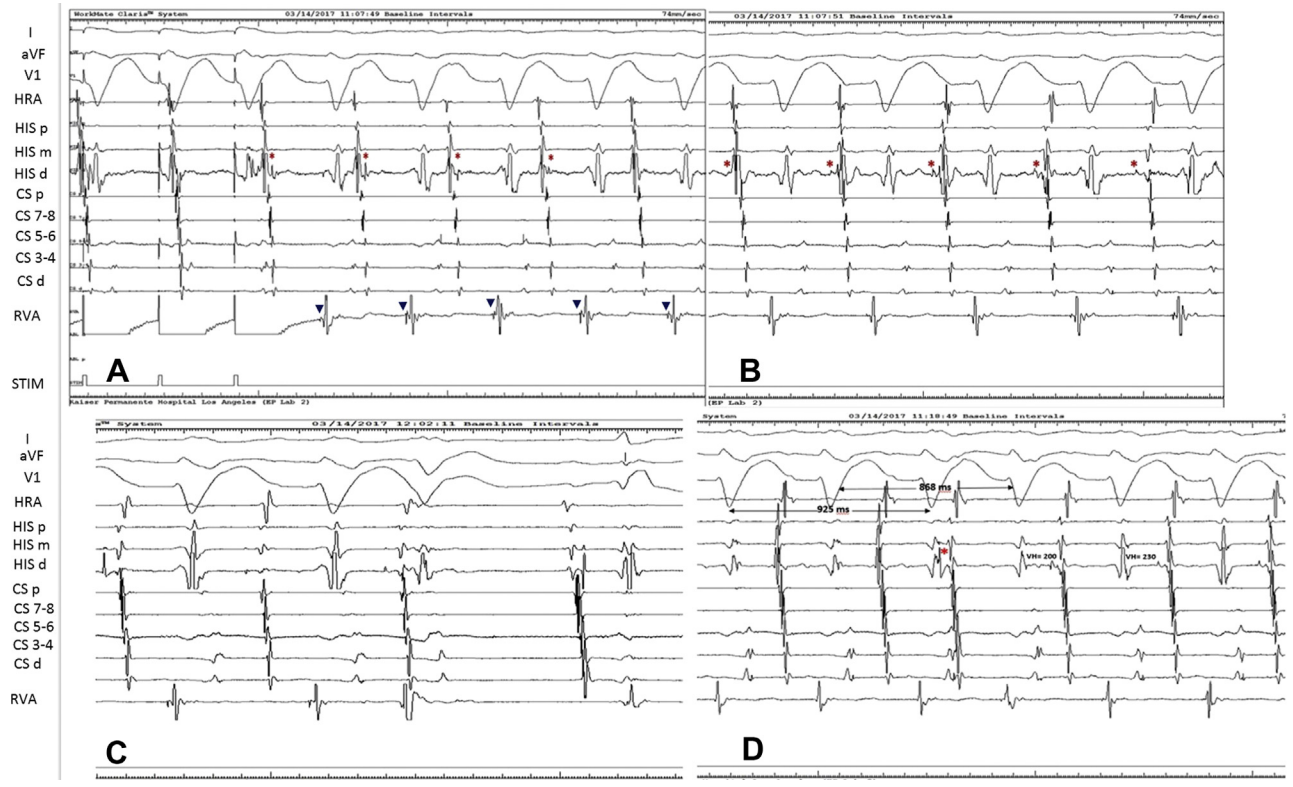

Figure 1 **A, B:** Induction of tachycardia with right ventricular pacing. His position marked by asterisk, right bundle potential marked by arrowhead. The His signal, initially dissociated, becomes activated retrogradely, as it emerges in front of the atrial electrograms. **C:** Response to spontaneous premature ventricular contractions that terminated the tachycardia. **D:** Resetting of tachycardia by His extrasystole, marked by asterisk.

whereas concealed entrainment with atrial pacing—often limited by AV node conduction—was possible, but with a longer HV interval (Figure 2A).

Similar to atrial pacing, the premature junctional beat induced during His catheter positioning (Figure 1D), conducted with the same VT morphology, and reset the tachycardia by advancing the succeeding retrograde His. Both responses observed would exclude reentrant fascicular VT and intramyocardial reentry VT with a long VH interval.

In addition, the consistent postinduction postpacing interval with RV pacing at the RB, that is = TCL + 10 ms, and the paced RV morphology that is identical to the VT (concealed fusion) (Figure 1), are both in support of BBR.

The diagnosis of BBR was eventually confirmed in this patient by observing the H-H interval variation, leading the V-V interval (Figure 2B). Of interest, longitudinal dissociation of the His was recorded during alternating bundle branch block (BBB) (induced and reversed by single PVCs) (Figure 3A).

The split H-H′ interval recorded with RB antegrade conduction (LBBB) was notably longer (100 vs 50 ms) than with LB antegrade conduction. The H′V of 150 ms,

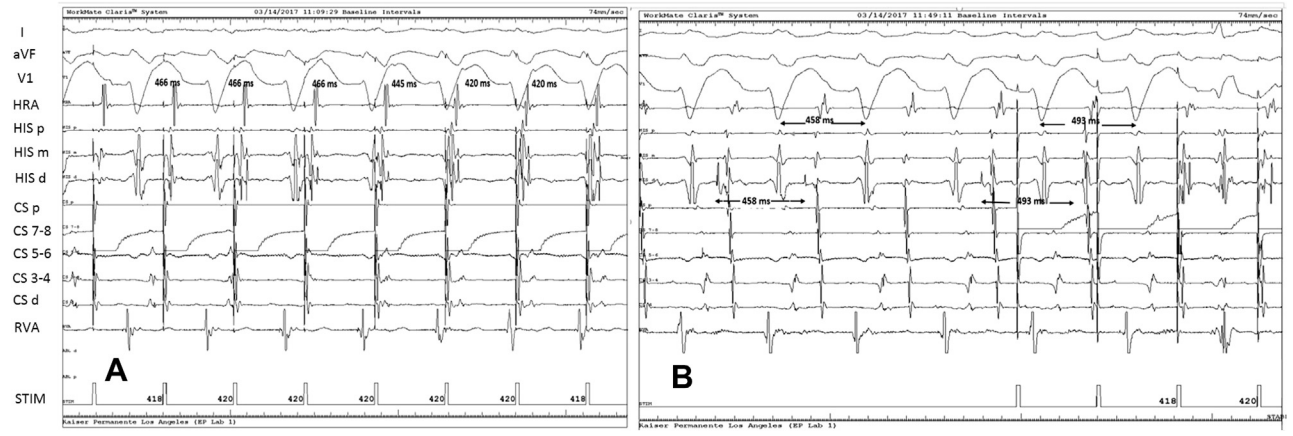

Figure 2 **A:** Entrainment of tachycardia with atrial pacing. R-R intervals marked in the figure. **B:** Realtionship of Δ H-H to Δ V-V.

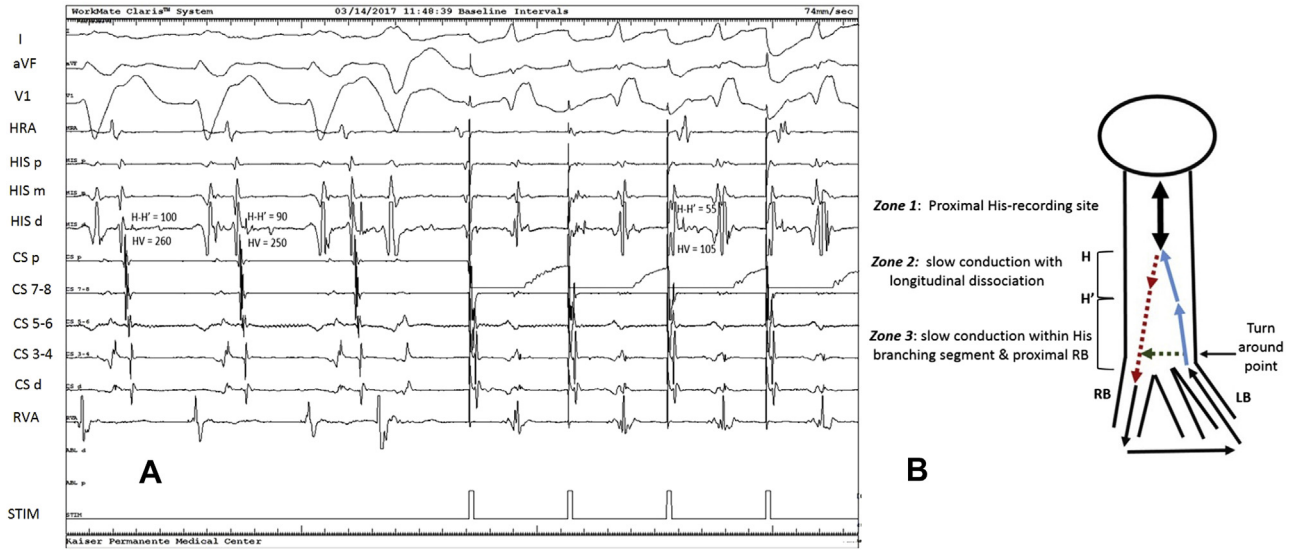

Figure 3 **A:** Split His (H-H′) recorded in sinus rhythm with left bundle (LB) branch block and right bundle (RB) branch block morphology. Note the association between Δ H-H′ and HV interval. **B:** Diagram of His zones, and turnaround point within bundle branch reentry circuit.

associated with RB conduction, despite a normal RB-V conduction time = 28 ms, recorded from the basal RV septum, supports a very proximal RB conduction disease, possibly within the branching segment of the His bundle at the pars membranacea, as described in patients with alternating BBB.[4,5] The above His findings can explain the rapid clinical deterioration to alternating BBB, high-grade AV block, and incessant BBR in <48 hours after this diagnostic procedure. After further evaluation, the patient was diagnosed with autoimmune pANCA vasculitis with multiorgan involvement (cardiac, pulmonary, and renal) and he was treated with prednisone and cyclophosphamide, which controlled all his arrhythmias. After 4 weeks on immunosuppressive medications, repeat electrophysiology study showed an HV = 65 ms, and there was no inducible BBR with pacing and Isuprel.

Discussion

Although a consistent His-RB/ventricular activation sequence is a diagnostic criterion for BBR that distinguishes it from other VT, theoretically it is possible to dissociate the entire His segment superior to the turnaround point (TP), which does not participate in the reentry circuit.[6]

In this patient, the intermittent His-RB/ventricular dissociation can be explained by a decremental intra-Hisian conduction zone lying between the recording site and the TP (Figure 3B), in the setting of a relatively slow BBR VT rate, and underlying sinus tachycardia with fast AV node conduction that competes for activation of the proximal His bundle. The decremental His conduction is also highlighted by the longer HV interval observed with atrial pacing and premature junctional beat.

The observation of longitudinal His dissociation associated with alternating BBB raises another question about its connection to BBR. The presentation of intra-Hisian conduction disease as BBB was reported in patients[7,8] as well as in experimental studies. In these studies, blunt trauma or ischemic injury to the His could lead to longitudinal dissociation (owing to disruption of transverse conduction within the His), which is marked by a split His recording.[9–11]

Of interest, RBBB was more common, a finding that was also noted with His bundle pacing.[12] It is possible that in this patient, the different conduction rates along the right and left bundle connections within the His, and the delayed transverse conduction along the TP, promoted the reentry mechanism, and although a split His during BBR was not recorded, this could have been missed by catheter instability or overlapped by other signals.

Conclusion

This report illustrates a variant presentation of BBR, and its link to intra-Hisian conduction disease and longitudinal dissociation—the prevalence of which remains to be determined in patients with BBR.

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