Para-Hisian pacing: Useful clinical technique to differentiate retrograde conduction between accessory atrioventricular pathways and atrioventricular nodal pathways

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Para-Hisian pacing is a useful tool to differentiate between retrograde conduction over an accessory pathway and retrograde conduction over the fast or slow atrioventricular (AV) nodal pathways. Para-Hisian pacing uses right ventricular (RV) pacing close to the His bundle or proximal right bundle branch (RBB). As the position of the ventricular pacing catheter changes subtly during respiration (or by changing pacing output), the pacing stimulus changes capture among (1) basal anteroseptal RV plus His bundle or proximal RBB (His bundle-RBB capture); (2) capture of basal anteroseptal RV alone; and (3) His bundle-RBB capture alone. These changes in pacing capture result in abrupt changes in the timing of His bundle activation relative to the timing of ventricular activation. The presence or absence of a change in atrial activation sequence, stimulus-atrial (SA) intervals, and His bundle-atrial (HA) interval identifies whether retrograde conduction is dependent on ventricular activation (retrograde conduction over an accessory pathway) or His bundle activation (retrograde conduction over the AV node) or both (accessory pathway and AV node; Figures 1 and 2). The loss of His bundle-RBB capture is usually identified by the widening of the QRS complex, indicating that some of the ventricular myocardium (farthest from the RV basal septal pacing site) is activated by the His-Purkinje system during both RV and His bundle-RBB capture.

Our preferred approach is to position the RV pacing catheter toward the RV outflow tract, 1–2 cm superior to the His bundle catheter. While pacing at moderate output (5–10 mA and 2 ms pulse width), the RV catheter is slowly withdrawn toward the His bundle catheter (proximal RBB) until intermittent His bundle-RBB capture occurs because of changes in catheter position during respiration. As the pacing catheter is moved closer to the His bundle, the ventricular potential in the His bundle electrogram becomes earlier and the retrograde His bundle potential becomes later, providing greater separation between the local ventricular and His bundle potentials. The use of closely spaced electrodes (1 mm edge-to-edge) on the His bundle catheter shortens the duration of the local ventricular potential in the His bundle electrogram, preventing the masking of the His bundle potential by the local ventricular potential. Closely spaced electrodes on the pacing catheter may provide a smaller pacing field, facilitating intermittent loss of His bundle-RBB capture with small changes in catheter position during respiration. A deflectable RV pacing catheter is positioned more easily for para-Hisian pacing and subsequent positioning of the pacing catheter close to the location of an accessory pathway (Figure 3A). In patients with proximal RBB block (such as resulting from previous ablation), His bundle-RBB capture requires pacing proximal to the RBB block site and may not be achieved from the RV. Other approaches include changing pacing output to achieve intermittent His bundle-RBB capture and use of the distal electrodes on the His bundle catheter for pacing.

Intermittent His bundle-RBB capture

Pattern 1 (Figure 2)

During para-Hisian pacing with continued RV capture, the loss of His bundle-RBB capture with no change in retrograde atrial activation sequence, no change in the SA interval (any electrogram), and a shorter HA interval indicate that retrograde conduction is dependent on ventricular activation and not His bundle activation, that is, conduction occurring over a single accessory pathway (Figures 2 and 3). However, this does not exclude the presence of retrograde conduction over the AV node with...
Figure 1  Schematic representation of response to para-Hisian pacing between conduction over the AV node alone (A), conduction over an accessory pathway alone (B), and conduction over the AV node and accessory pathway combined (C).

Figure 2  Algorithm for interpretation of the response to para-Hisian pacing (see text for explanation).
longer conduction time (even during His bundle-RBB capture; Figure 4) or a second accessory pathway with either longer conduction time or located far from the pacing site.3

In patients with both concealed anteroseptal accessory pathway and retrograde fast AV nodal pathway conduction, ventricular pacing at this site without His bundle-RBB capture allows selective retrograde conduction over the accessory pathway for mapping (Figures 3D and 4A). In patients with a posteroseptal accessory pathway, the delay in retrograde His bundle activation during ventricular pacing at this site without His bundle-RBB capture may be sufficient for mapping selective retrograde accessory pathway conduction (Figure 5). In patients where retrograde AV nodal conduction masks retrograde posteroseptal accessory pathway conduction, positioning the ventricular pacing catheter close to the posteroseptal tricuspid annulus (or proximal branches of the coronary sinus [CS]) provides selective retrograde accessory pathway conduction for mapping. In contrast, ventricular pacing from the RV apex (close to the Purkinje-myocardial junction and far from the accessory pathway) often results in selective retrograde AV nodal conduction or fusion of AV nodal and accessory pathway conduction.

Patterns 2 and 3

The loss of His bundle-RBB capture with no change in retrograde atrial activation sequence and an increase in the SA interval can indicate retrograde conduction over either an accessory pathway or the AV node. If there is a
similar increase in the local VA interval near the site of earliest atrial activation and the HA interval shortens, retrograde conduction is occurring over a single accessory pathway (pattern 2; Figure 2). As in pattern 1, this response does not exclude the presence of retrograde conduction over the AV node or a second accessory pathway.

If the increase in the SA interval is associated with a similar increase in the SH interval with little or no change in the HA interval, retrograde conduction is occurring over the AV node (pattern 3; Figure 4A). Para-Hisian pacing may be the only technique to distinguish between retrograde accessory pathway and slow AV nodal pathway conduction during or after ablation of an epicardial posteroseptal accessory pathway due to the nearly identical retrograde atrial activation sequences (Figure 5). Both use the CS myocardium, with early activation of the floor of the proximal CS and connection with the left atrium 2–4 cm from the CS ostium (Figures 5D and 5E).

**Patterns 4 and 5**

Change in atrial activation sequence with loss of His bundle-RBB capture indicates that retrograde conduction is occurring over (1) an accessory pathway and the AV node; (2) two or more accessory pathways; or (3) fast and slow AV nodal pathways. If the increase in the SH interval is similar to the increase in SA interval in the His bundle electrogram, with little or no change in the HA interval, retrograde conduction is occurring over the AV node and an accessory pathway (Figures 2 and 6). Without recording electrograms near the accessory pathway, the change in the atrial activation sequence may not be identified, incorrectly suggesting that retrograde conduction is occurring over just the AV node (Figure 6). This is most likely to occur in patients with a short retrograde AV nodal conduction time (short HA interval) and an accessory pathway located far from the pacing site (i.e., left free-wall accessory pathway).

If the HA interval shortens, the presence of two or more accessory pathways can be differentiated by moving the ventricular pacing catheter close to each of the sites of early retrograde atrial activation. Pacing at these sites should facilitate selective conduction over each of the accessory pathways (short local VA interval and minimum fusion in atrial activation sequence).

Fusion of retrograde conduction over the fast and slow AV nodal pathways usually occurs within a very limited range of ventricular pacing cycle length (CL). Change in atrial activation sequence with loss of His bundle-RBB capture results from the lengthening of the HH interval. Para-Hisian pacing can often be performed at a long CL (fast pathway) and a short CL (slow pathway), confirming that each pathway is dependent on His bundle activation.

**Intermittent ventricular capture**

**Pattern 6**

During para-Hisian pacing with continued His bundle-RBB capture, the loss of ventricular capture with no change in retrograde atrial activation sequence, SA interval, or HA interval indicates that retrograde conduction is dependent on His bundle activation and not ventricular activation, that is, conduction occurring over the AN node.

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**Figure 4** Para-Hisian pacing in another patient with a concealed anteroseptal accessory pathway. **A:** Before ablation, the loss of His bundle-RBB capture in the right complex (SH 60 ms and wider QRS) resulted in the same atrial activation sequence, but with a 5-ms increase in SA interval (30 to 35 ms) due to a 5-ms increase in the stimulus-ventricular (SV) interval (10 to 15 ms) at the site of earliest atrial activation (pattern 2 in Figure 2). **B:** After ablation, the SA interval was longer but retrograde atrial activation was early in the His bundle electrograms similar to before ablation. Without His bundle-RBB capture (left complex), the SH interval was 65 ms. With His bundle-RBB capture (right complex), the SH interval shortened by 50 ms (65 to 15 ms). The SA intervals also shortened by 50 ms (185 to 135 ms and 200 to 150 ms) with no change in atrial activation sequence, indicating retrograde conduction over the AV node (pattern 3 in Figure 2).
Pattern 7

In patients with retrograde conduction over only a single accessory pathway, the loss of ventricular capture results in an increase in the SA interval (and HA interval), with little or no change in the local VA interval near the site of earliest atrial activation.

Patterns 8 and 9

When loss of ventricular capture is associated with a change in retrograde atrial activation sequence with little or no change in the HA interval, retrograde conduction is occurring over the AV node and an accessory pathway. If the HA interval lengthens with the change in retrograde atrial activation sequence,
retrograde conduction may be occurring over the AV node and an accessory pathway or over two or more accessory pathways. These two options can often be differentiated by obtaining ventricular capture with and without His bundle-RBB capture (retrograde AV nodal conduction will be delayed by the loss of His bundle-RBB capture) or by pacing close to each of the sites of early retrograde atrial activation as described.

References


