

## Alternating bundle branch block during atrial bigeminy

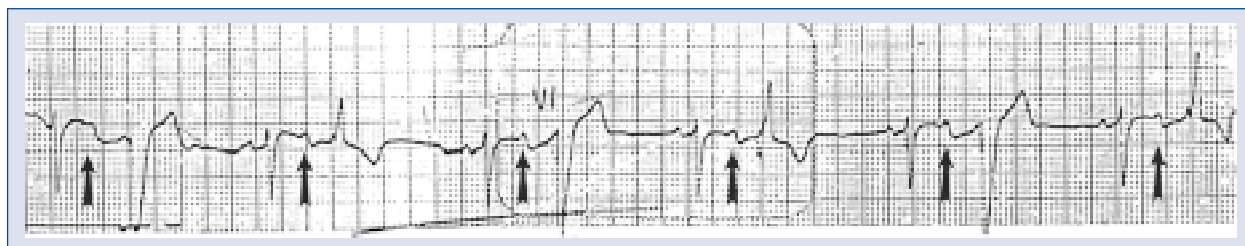
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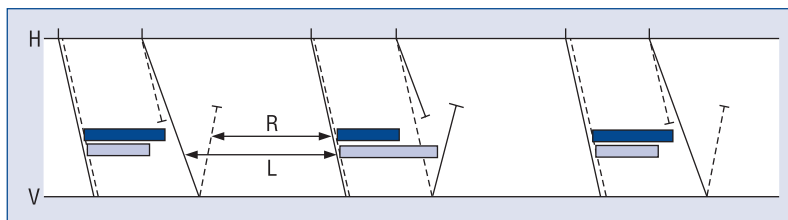
Alternate patterns of ventricular excitation may occur with any type of supraventricular bigeminy. It is a physiologic phenomenon that depends on the rate dependency of bundle-branch refractoriness and the linking phenomenon related to concealed retrograde penetration of aberrantly conducted beats into their own blocked bundle branch [1–3]. An alternate pattern of ventricular activation can only occur if the coupling intervals of the early atrial premature complexes, the refractory periods of the bundle branches, and the anterograde and retrograde conduction times within the bundles present a favorable combination of factors critical for alternation of ventricular activation. Figure 1 is an ECG of lead V1 showing atrial bigeminy with alternating bundle branch block in a 20 year-old woman without heart disease who complained of a skipping sensation in her chest. The coupling intervals of all the atrial extrasystoles were identical. The QRS complex during right bundle branch block (RBBB) is slightly longer than 0.12 s with careful scrutiny of the initial forces best seen in the last complex [4].

### Discussion

Alternating bundle branch block (in contrast to alternating degrees of aberration [2]) during spontaneous atrial bigeminy has rarely been reported [1–3]. The most widely accepted explanation of alternating aberration during supraventricular bigeminy involves the following principles: (1) Cycle-length dependency of the refractory periods within the His-Purkinje system (Ashman phenomenon). A relatively long cycle is followed by a relatively long refractory period and a relatively short cycle is followed by a relatively short refractory period; (2) Linking or transeptal retrograde concealed conduction or retrograde invasion of the blocked bundle (exhibiting delayed or blocked conduction) by the impulse from the contralateral bundle branch that conducts [5]. The ladder diagram in Figure 2 illustrates these concepts [3]. The broken lines represent anterograde and retrograde conduction over the right bundle branch; shaded bars represent the refractory periods of the right bundle. Continuous lines and empty bars indicate left bundle-branch



**Figure 1.** ECG lead V1. Sinus rhythm and atrial bigeminy conducted with alternating bundle branch block. The faint almost invisible rectangle between the 3<sup>rd</sup> and 4<sup>th</sup> arrows, marks where the single-lead ECG was scooped out with a special instrument for mounting. The segment was salvaged in time and reapplied to the tracing by means of rubber cement, with an almost perfect match. See text and Figure 2 for details.



**Figure 2.** Ladder diagram illustrating the suggested mechanism of alternating bundle branch block aberrancy during supraventricular bigeminy. Broken lines represent anterograde and retrograde conduction over the right bundle branch. The light blue bars indicate the refractory periods of the right bundle. Continuous lines and dark blue bars indicate left bundle branch conduction and refractoriness respectively; H — activation at the level of the His bundle; V — ventricular activation; R — effective activation interval of the right bundle branch prior to the second sinus beat, L — effective activation interval of the left bundle branch prior to the second sinus beat. See text for detail. Modified and reproduced from reference [3] with permission.

conduction and refractoriness, respectively. The first premature impulse conducts with RBBB because of the longer refractory period of the right bundle and therefore it conducts exclusively over the left bundle branch. At the ventricular level, it then invades the right bundle retrogradely. The late retrograde activation of the right bundle branch delays its cycle so that the effective activation interval of the right bundle prior to the next sinus beat is, therefore, shortened (R) resulting in a shorter right bundle-branch refractoriness (indicated by the shorter cross-hatched bar on the second sinus beat). The effective activation interval of the left bundle branch (L) becomes longer than that of the right bundle branch (R), hence the duration of left bundle-branch refractoriness increases as indicated by the longer open bar following the second sinus beat. The second premature impulse will now conduct with left bundle-branch block, then invade the left bundle retrogradely, and reset the cycle in the other direction. The effective activation cycle of the right bundle branch is now prolonged resulting in a longer right bundle branch refractoriness for the third sinus beat but left bundle branch refractoriness for the third sinus beat is shorter because previous retrograde activation shortened the effective activation interval of the left bundle branch. The disparity of refractoriness associated with the third sinus impulse causes the bigeminal premature atrial impulse to be conducted with RBBB thereby perpetuating the bundle branch block alternation.

The concept of linking is supported by the demonstration of retrograde activation into the right bundle branch by direct recordings of the right bundle branch potential during electrophysiologic studies [6, 7].

A slightly different explanation also invokes alternating changes in the refractory periods of the bundle branches, but it assumes that unequal acti-

vation intervals at the distal levels are due to alternate differences in timing of anterograde rather than retrograde impulses. However the weight of electrophysiologic evidence strongly favors linking or concealed retrograde bundle branch invasion (re-entry) rather than a simple anterograde delay in the bundle branches [3].

## Disclosures

The authors do not report any conflict of interest regarding this work.

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