Simulated 2:1 Left Bundle-Branch Block

Normalization of the Left Bundle-Branch Block Pattern by Ventricular Extrasystoles

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VENTRICULAR extrasystoles can occur anywhere in the cardiac cycle. When they occur toward the end of diastole they may be synchronous with the next conducted impulse resulting in a fusion complex. We report a case of left bundle-branch block associated with end-diastolic ventricular extrasystoles that occur in bigeminal rhythm; this results in fusion complexes that apparently normalize the bundle-branch block pattern. The resulting arrhythmia simulates 2:1 left bundle-branch block.

Case Report

The electrocardiograms are those of a 35-year-old African woman who died of hypertensive heart disease with complicating pleural empyema. Figure 1 (continuous strip of standard lead II) shows a basic pattern of left bundle-branch block with alternate complexes becoming progressively more normal, giving the appearance of 2:1 left bundle-branch block. The P-R intervals of all the beats are constant. The rhythm is interrupted by a short period of paroxysmal ventricular tachycardia with retrograde conduction to the atria. This sequence of events is again shown in figure 2 (continuous strip of lead V1 in the same recording). The beginning of this strip shows left bundle-branch block only in the first three complexes; this is followed by gradual, progressive, normalization of alternate complexes, so that eventually a pattern of 2:1 left bundle-branch block appears.

The mechanism of this arrhythmia becomes apparent from another section of the same recording (fig. 3) which shows the same left bundle-branch block pattern with alternate ventricular extrasystoles having the same basic pattern as the complexes of the ventricular tachycardia. However, their occurrence in end-diastole synchronously or near synchronously with supraventricular impulses results in various fusion complexes, some of which normalize the bundle-branch block pattern.

Discussion

When impulses from two origins (e.g., supraventricular and ventricular or ventricular from two foci), discharge synchronously or near synchronously, simultaneous invasion of the ventricles may occur, each impulse stimulating part of the ventricular musculature. These impulses may modify the QRST complex so that its contour is intermediate between that of the unmodified individual or principal complexes. As the two impulses usually discharge with varying relationship to each other, e.g., parasystole, fusion complexes of various types may result, depending on the amount of ventricular muscle controlled by each pacemaker.

Bisteni and his associates have shown experimentally that, in the presence of left bundle-branch block, the occurrence of a ventricular extrasystole in end-diastole—between the peak of the P wave and the beginning of the QRS complex—from a focus in the ventricle of the blocked side may result in a fusion beat that normalizes the bundle-branch block pattern.

In left bundle-branch block, left ventricular activation occurs late. This may, however, be counterbalanced by a ventricular extrasystole originating in the left ventricle more or less synchronously with supraventricular activation. Thus, left and right ventricular activation occur together, and normalization of the complex results.

Various types of fusion complexes may occur depending on the timing of the ectopic and ventricular discharges. When the ectopic focus discharges near the P wave of the ensuing sinus beat, the ventricles are activated almost entirely by the ectopic stimulus and the QRS complex is bizarre. The later the ectopic stimulus occurs, the greater is the op-

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Figure 1
Electrocardiogram (continuous strip of standard lead II). Full description in text.

Figure 2
Electrocardiogram (continuous strip of lead V1). Full description in text.

Opportunity for synchronism with the supraventricular impulse and a consequent fusion complex that normalizes the pattern of bundle-branch block. This is demonstrated in figure 3. The true ectopic ventricular complex may be seen in the first two beats of the ventricular tachycardia (complexes 25 and 26). The true supraventricular complex—the left bundle-branch block pattern—can be seen in complexes 7, 9, 11, 13, 15, 17, 19, 20, 21, and 23. The other complexes represent varying degrees of fusion that depend on the timing and relationship of the supraventricular and ectopic impulses. For example, complex four occurs just after the P wave, well before the arrival of the next supraventricular impulse, and ventricular activation is therefore entirely by the ectopic stimulus; the complex thus resembles that of the ventricular tachycardia. Complex 22 resembles the true bundle-branch block pattern. Activation of this complex is therefore predominantly supraventricular with the extrasystolic impulse occurring late and thus influencing only the terminal deflection of the bundle-branch block pattern. The resulting pattern resembles a normally conducted supraventricular complex. Note that the P-R interval of this fusion complex is the same as that of the pure conducted beat. Other extrasystolic complexes represent varying degrees of fusion between these two extremes. For example, complex six probably represents equal activation by supraventricular and extrasystolic impulses; normalization is again evident. The pattern of complexes 2, 4, 8, 10, 12, 14, 16, and 18...
bear a greater resemblance to the true ectopic complex and are therefore a result of domin-ant ectopic activation.

Since the coupling interval of the extrasys-toles approaches the sinus cycle length, the different degrees of ventricular fusion may be caused by sinus arrhythmia or variation in the coupling intervals or both. The variation in the fusion complexes in our case was due predominantly to the presence of slight sinus arrhythmia (fig. 3, mean sinus cycle length 0.62 second; range 0.60 to 0.64 second). The coupling intervals (fig. 3) are constant at 0.60 second except for the intervals be-tween complexes 19 and 20 and 21 and 22; these intervals are at least 0.62 and 0.63 sec-ond respectively (the modification of the terminal vector only, makes accurate measure-ment difficult).

The mechanism of apparent 2:1 left bundle-branch block seen in figures 1 and 2 now becomes explicable. The extrasystoles occur toward the end of supraventricular activation, affecting only the terminal deflection and gradually encroaching further on the bundle-branch block complex until normalization results. This is well seen in the begin-ning of each recording; in figure 1 the ter-

Figure 3
Electrocardiogram (continuous strip of lead V_1). Full description in text. A, atrial level; A-V, nodal level; V, ventricular level.
minal deflection of alternate bundle-branch block complexes is progressively more affected until normalization results; in figure 2 this commences with the fourth complex.

True 2:1 bundle-branch block is a rare arrhythmia. The reason for this is that the bundle branch below the blocked area is activated by the impulse from the contralateral branch and is thus refractory at the time of arrival of the next supraventricular impulse.

A 2:1 bundle-branch block may be simulated by two different mechanisms: 1. Extrasystolic ventricular bigeminal rhythm, during sinus rhythm with normal intraventricular conduction, when the extrasystoles occur late in diastole. In such cases it is the ectopic impulse that simulates the bundle-branch block. Careful inspection, however, will reveal that the P-R interval of the so-called bundle-branch block complex is shorter than that of the normal complex. 2. The mechanism of the arrhythmia described here. In this case it is the apparent normal complex that is due to a fusion between the bizarre pattern of the ventricular extrasystole and the bundle-branch block pattern of the supraventricular impulse. As the terminal deflection is chiefly affected, the P-R interval of the fusion complex is the same as that of the conducted impulse.

Four conditions are necessary for the occurrence of this arrhythmia. 1. The supraventricular impulses must have a bundle-branch block pattern. 2. There must be a discharging ectopic focus in the ventricle of the blocked side. 3. The focus must discharge in bigeminal rhythm. 4. The ectopic impulse must discharge in end-diastole synchronously with the supraventricular impulse.

This arrhythmia should be suspected when in apparent 2:1 bundle-branch block, the so-called normal complexes show slight variation in shape affecting particularly the terminal deflection.

Summary

A case is presented of end-diastolic ventricular extrasystoles occurring in bigeminal rhythm during left bundle-branch block; this results in fusion complexes that normalize the bundle-branch block pattern and simulate 2:1 left bundle-branch block.

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References

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