VENTRICULAR FUSION BEATS SIMULATING BILATERAL, BUNDLE BRANCH BLOCK

Kenneth S. Gimbel, M.D.*

Fusion beats result from the simultaneous activation of a cardiac chamber by two separate wave fronts. This phenomenon, frequently encountered in clinical electrocardiography, sometimes produces diagnostic confusion. The present case emphasizes the value of understanding the fusion process in the analysis of a complex arrhythmia.

CASE REPORT

A 61-year-old white man experienced severe retrosternal chest pain abruptly terminated by loss of consciousness. Upon arrival to the accident floor, he was cyanotic, apneic, and pulseless. An electrocardiogram obtained during cardiopulmonary resuscitation displayed ventricular fibrillation which was converted to sinus rhythm by a single direct current shock. The monitored ECG demonstrated sinus rhythm, first degree atrioventricular (AV) block (PR=0.24 second) and complete left bundle branch block (LBBB). Intermittent Mobitz type I AV block uncovered a subsidiary ventricular pacemaker which resulted in a complex arrhythmia mimicking bilateral bundle branch block (BBBB).

ANALYSIS OF THE ARRHYTHMIA

The upper tracing in Figure 1 displays sinus rhythm, first degree AV block, and complete LBBB. The eighth P wave fails to activate the ventricles, and 2:1 AV conduction ensues.

AV conduction improves at the beginning of the middle tracing as evidence by the appearance of 3:2 AV block of the Wenckebach type. This is

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Figure 1. Consecutive rhythm strips, Lead I, paper speed 25 mm/sec. Upper tracing: Sinus rhythm, onset of 2:1 AV block. Middle tracing: 3:2 AV block, paroxysm of accelerated idioventricular rhythm. Lower tracing: Left ventricular escape rhythm with repetitive fusion. Abbreviations: A=atrial conduction, AV=atrioventricular conduction, EB=escape beat, FB=fusion beat, P=P wave, V=ventricular conduction.
interrupted by a paroxysm of slow ventricular tachycardia, which terminates by gradual deceleration.

In the lower tracing sinus rhythm with 2:1 AV block persists. Complex No. 1 is identical to the conducted beats observed in the upper two tracings: PR = 0.24 sec, QRS duration = 0.15 sec, LBBB contour, with secondary ST segment and T wave changes. Complex No. 7, however, has the characteristics of complete right bundle branch block (RBBB): QRS = 0.14 sec, and the narrow R wave is followed by a deep, and slurred S wave. Complexes No. 2 to 6 demonstrate a gradual transition in contour from one resembling incomplete LBBB to one resembling incomplete RBBB.

The PR interval preceding complex No. 2 remains 0.24 sec, but the QRS duration has decreased to 0.12 sec, and the ST segment is less negative. Complex No. 3 follows a normal PR interval (0.20 sec). A small initial q wave has appeared and the QRS duration has further diminished to 0.10 sec. Complex No. 4 appears to be completely normal: PR = 0.18 sec, QRS = 0.08 sec, the ST segment is isoelectric, and the T wave is upright. Complex No. 5 is preceded by a PR interval of 0.16 sec, and the QRS duration has increased to 0.11 sec. This is secondary to a terminal conduction delay, suggesting incomplete RBBB. Complex No. 6 displays further attenuation of the PR interval (0.14 sec), and an increase in the size of the terminal S wave (QRS = 0.13 sec).

The mechanism responsible for this stepwise alteration in QRS morphology becomes apparent after careful examination of complex No. 7. It is unlikely that ventricular depolarization is the consequence of the preceding sinoatrial (SA) node impulse, since the PR interval is slightly less than 0.08 sec. Complex No. 7 most probably is generated by the escape of a subsidiary pacemaker situated within the Purkinje tissue of the left ventricle. Complexes No. 2 to 6 represent a series of ventricular fusion beats. Control of ventricular activation is shared by two pacemakers; the SA node impulses reach the ventricles via the intact right bundle, while a second wave front spreads from the escape focus.

The onset of 2:1 AV conduction permits the previously latent escape focus to compete for control of the ventricles. The similarity between the frequency of the subsidiary pacemaker and the interval separating conducted SA nodal impulses results in repetitive interaction between the two. The cycle length of the escape pacemaker is directly measurable as the R-R interval between complexes No. 6 and 7: 1.29 sec, or 46 per minute. The effective SA node cycle length, defined as the interval separating two successfully conducted P waves averages 1:32 sec, or 45 per minute. Because the escape focus discharges at a rate that is slightly in excess of the effective SA nodal rate, its effect is exerted earlier with each succeeding cycle, and its influence upon the sequence of ventricular excita-

Figure 2. Consecutive rhythm strips, Lead I, paper speed 25 mm/sec. Upper tracing: Sinus rhythm, 2:1 AV block. Lower tracing: Left ventricular escape rhythm with repetitive fusion. Abbreviations: same as for Figure 1.
Ventricular fusion beats simulating BBB

tion gradually assumes dominance. The lower tracing in Figure 2 is repetition of this sequence of events.

Discussion

In the presence of LBBB, critically timed left ventricular ectopic beats may yield complexes of normal contour and duration. Freerexcitation of the left ventricle at this "critical moment" normalizes the sequence of ventricular activation, thus cancelling out the effects of the left bundle branch conduction delay. Stimulation of the left ventricle slightly before and after the critical moment produces QRS patterns exhibiting varying degrees of RBBB and LBBB.

Coexistent conduction delay within the major subdivisions of the His bundle may produce ECG abnormalities resembling those demonstrated in Figures 1 and 2. In the presence of bundle branch block, prolongation of the PR interval may indicate simultaneous conduction delay in the contralateral bundle, the His bundle, or the AV node. The subsequent development of 3:2 AV conduction with Wenckebach periodicity in the present case suggests that the major site of the AV block is proximal to the His bundle.

The appearance of RBBB and LBBB patterns in successive beats, with or without PR interval variation, implies bilateral intermittent and asynchronous bundle branch block. In this patient, ectopic impulses from the left ventricle exhibiting a RBBB configuration account for the alternation. Incremental conduction delay in the right bundle superimposed upon a stable LBBB, will yield QRS alterations similar to that observed in Figures 1 and 2. Under these circumstances, the PR interval should gradually prolong rather than diminish as in the present case. Casual inspection of these tracings, therefore, may lead to the erroneous diagnosis of bilateral bundle branch block.

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References


Chinese Jade Sculptures

The actual fashioning of a jade sculpture is a remarkable, arduous procedure. To begin with, a portion of the outer covering or rind is cut away and polished to reveal the inner color qualities or veins of the material. It is then decided, according to shape, size and color composition, the subject best suited for the rough. In modern shops the manager makes this decision. He then hands the cutting job to the first of many workmen. Each carver specializes in one or more phases of the carving process. The working of jade is done by hand-operated, simple machinery equipped with tools similar to dentists' drills. Undoubtedly, in earlier times there were individual artists who conceived the design and carved the jade in its entirety.

Hartman JM: Chinese Jade of Five Centuries. Rutland, Vermont, C E Tuttle, 1969