Changes in the Pattern of Old Inferior Wall Myocardial Infarction Produced by Acute Left Bundle Branch Block and Hemiblock*

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Varying degrees of functional conduction disturbances occurred in two patients with old IWMI during aberration of spontaneous, or induced, premature atrial contractions. Ventricular complexes transitional in form between those having normal (control) intraventricular conduction and those showing the most advanced grades of LBBB, LAH, LPH were interpreted as “incomplete” forms of the latter. Increasing degrees of LBBB first obscured, and finally masqueraded, the residual QRS changes of IWMI. On the other hand, IWMI could be suspected in beats showing LAH and RBBB since the left axis shifts produced by LAH were associated with Q waves in leads 2 and 3. However, the diagnosis of IWMI was impossible when LAH appeared without RBBB. Three possible explanations were offered for this paradox phenomenon, namely that: a) it was the RBBB not the LAH which permitted the diagnosis of IWMI when both processes coexisted; b) a minor degree of LBBB was present; and c) the site (s) at which the impulse entered into the ventricles varied with different degrees and combinations of functional blocks. Finally, LPH was characterized by an increase in the height of the R waves in leads 2 and 3 without a concomitant change in the size of the q waves. Hence, LPH made the diagnosis of IWMI more difficult.

Conventional electrocardiographic studies have indicated that although the presence of right bundle branch block (RBBB) imposes no difficulty in the diagnosis of inferior wall myocardial infarction (IWMI) left bundle branch block (LBBB), left anterior hemiblock (LAH) and left posterior hemiblock (LPH) more often than not, appear as insurmountable obstacles. Therefore, it seemed of interest to discuss the variations produced by intermittent bundle branch block, LAH and LPH in the residual QRS changes of IWMI.

CASE REPORTS

Two patients referred for evaluation of symptomatic sinus bradycardia were studied. Both had sustained an electrocardiographically documented IWMI less than a year previously. His bundle recordings were obtained in one of them by conventional catheter techniques. In addition, an attempt was made to stimulate the low right atrium with the purpose of inducing aberrant ventricular conduction. Coupled pacing was performed with a stimulator adequate for continuous, coupled or paired stimulation. In the second patient spontaneous atrial beats were also present. The variability in duration of the cycle lengths precluded the establishment of a meaningful relation between the coupling intervals and the resulting QRS changes.

CASE 1

The tracings in Figures 1 and 2 were recorded at a paper speed of 100 mm/sec. The first beat in Figure 1, which was of sinus origin, showed a small q wave in lead 2 and a much larger and wider Q wave in lead 3. Absence of an initial negative deflection in lead 1 was attributed to a minor degree of LBBB or to septal extension of the IWMI. The electrical axis pointed toward -30°. Ventricular complexes in chest lead V1 consisted of a small r wave followed by a larger S wave. QRS duration was 105 msec. An electrical stimulus...
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In each panel the first beat was a junctional escape and the second, a premature (spontaneous or artificial) atrial beat with different types of aberrant ventricular conduction. The QRS complexes of the junctional escapes were similar to those of sinus origin in regard to morphology (interoposterior infarction pattern), duration (110 msec) and electrical axis (+40°).

Figure 3 shows functional RBBB (manifested by wide and tall R waves in V2) associated with varying degrees of left axis deviation, from extreme left in the first panel to around −20° in the last panel. According to the "trifascicular" concept of intraventricular conduction these changes can be attributed to more or less advanced grades of LAH. Although lead 1 had small q waves, initial positive deflections were not seen in leads 2 and 3. Hence, inferior wall infarction could still be the diagnosis when LAH coexisted with RBBB.

Figure 4 resembled Figures 1 and 2 in that aberration of an advanced LBBB type abolished the pre-existing q waves in leads 2 and 3.

In Figure 5 the aberrant ventricular pattern noted in V2 consisted of a small r wave followed by a larger S wave. This morphology excluded the presence of RBBB, which was characterized by an increased height of the R wave in V2 (Fig 3). Moreover, the aberrant beats showed (from left to right) increasing degrees of left axis deviation, in turn attributed to different grades of LAH. There were small q waves in lead 1 and initial positive deflections in leads 2 and 3. In contrast with Figure 3, LAH (not associated with RBBB) abolished the residual QRS changes of interoposterior wall myocardial infarction.

The functional conduction disturbances appearing in Figure 6 had different characteristics. Advanced RBBB was excluded because the R waves in V2 were only slightly taller than in control beats. The corresponding ventricular complexes did not show q waves in lead 1. The R waves in leads 2 and 3 were distinctly taller than in control beats, but the size of the q waves did not change. Different degrees of axis deviation also occurred, from slightly to the right of control values (first panel) to definitely to the right of +90° in the last panel. According to the "trifascicular" concept of intraventricular conduction these beats could have shown various grades of LPH.

Aberrant conduction of the LPH type made the diagnosis of previous IWMl difficult since the q wave appeared small (in leads 2 and 3) when compared to the height of the R waves.

**Figure 1.** Case 1. Effects of functional, advanced, left bundle branch block (LBBB) on the residual QRS changes of inferior wall myocardial infarction (IWMl). St = pacemaker stimulus artifact delivered to the low right atrium. HBE = His bundle electrogram, H = His bundle deflection. In Figures 1 and 2 paper speed was 100 mm/sec.

(St) delivered to the low right atrium propagated to the ventricles through the His bundle with a prolonged P-R interval. The resulting QRS complex was wide (125 msec in duration) and had a LBBB morphology. Q waves were no longer seen in leads 2 and 3. The latter showed an R, and an rsR', pattern, respectively. A QS morphology had replaced the rs complexes in lead V1.

Premature atrial stimuli (second beat in every panel of Fig 2) reached the ventricles with increasing (from left to right) degrees of left bundle branch block. The lesser grade of induced LBBB (left sided panel) was characterized by the decrease of the r wave in V1 and of the Q wave in lead 3. The latter deflection became even smaller in the middle panel, finally disappearing in the last panel, which showed (as in Fig 1) an advanced degree of LBBB.

To summarize, LBBB reduced or abolished the initial negative deflection in the inferior leads, as well as the early positivity in the right chest lead V1.

**Case 2**

Figures 3 to 6 were recorded (at a paper speed of 25 mm/sec) from a 63-year-old patient who developed a sick sinus syndrome after an interoposterior wall myocardial infarction. In each panel the first beat was a junctional escape and the second, a premature (spontaneous or artificial) atrial beat with different types of aberrant ventricular conduction. The QRS complexes of the junctional escapes were similar to those of sinus origin in regard to morphology (interoposterior infarction pattern), duration (110 msec) and electrical axis (+40°).

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**Figure 2.** Case 1. Masquerading effects of different degrees of functional LBBB on the residual QRS changes of IWMl.

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FIGURE 3. Case 2. Effects of different degrees of functional RBBB and LAH on the residual QRS changes of inferoposterior wall myocardial infarction. The atrial extrasystoles (with aberrant conduction) appearing in the second and third panels were induced by electrical stimulation of the low right atrium. Those shown in the first and last panel occurred spontaneously. In the last panel the stimulus artifact fell on top of the naturally-occurring P wave, thus being ineffective.

COMMENT

Complete and Incomplete Bundle Branch Block and Hemiblock

Both morphology and QRS duration have been used in the diagnosis of complete bundle branch block. Yet, a "complete" bundle branch block pattern does not always indicate that conduction is totally interrupted through the corresponding branch. Katz and Pick observed that a conduction delay of a little more than 60 msec could produce an electrocardiographic morphology indistinguishable from total anatomic interruption of a bundle branch. Therefore, the term "complete" bundle branch block as used in daily electrocardiographic interpretation should be understood in a functional, rather than in an anatomic sense.

This reasoning also applies to left hemiblocks in spite of a recent study suggesting that the hemiblock concept has no factual anatomic basis. From the electrophysiologic viewpoint LAH and LPH were considered as conduction defects occurring at any level (proximal or distal) of the anterosuperior or inferior radiations of the left bundle branch which resulted in exclusive arrival of excitation at given inferior and anterosuperior left ventricular endocardial sites, respectively. The resulting patterns of ventricular activation were responsible for the characteristic axis shifts seen in LAH and LPH, thus considered. Recently the concept of "incomplete" bundle branch block as conceived by Wilson and co-workers has been extended to the hemiblocks as well in the presence of intermittent ventricular conduction defects QRS complexes transitional between those having the control morphology and those showing the most advanced degrees of LBBB, RBBB, LAH.

FIGURE 4. Case 2. Masquerading effects of a functional, advanced, left bundle branch block pattern on the residual QRS changes of infero-posterior wall myocardial infarction. Similar changes were noted in Figures 1 and 2, right side of panel.
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LAH + ILBBB

Figure 5. Case 2. Masquerading effects produced by LAH on the residual QRS changes of IWMI. All three panels show spontaneous atrial extrasystoles with aberrant conduction. In the first panel the pacemaker stimulus artifact was delivered after appearance of the P wave, therefore being ineffective.

and LPH were considered as incomplete forms of the latter.

The most strict criteria for the diagnosis of LAH and LPH require deviations of the electrical axis to $-60^\circ$ and $+120^\circ$, respectively.\(^8\)

Obviously the existence of “incomplete” hemi-

LPH

Figure 6. Case 2. QRS changes produced by different degrees of functional LPH appearing after spontaneous atrial extrasystole. In all three panels the stimulus artifacts occurred after the P waves, therefore being ineffective.

blocks is difficult, albeit impossible, to establish in the presence of sinus beats with electrical axis in the normal range. This diagnosis can be made in cases of intermittent hemiblock (as in Figures 3-6) in which the corresponding changes occur almost on a beat-to-beat basis so that the resulting axis shifts can be compared to control values.

LBBB in IWMI

Wilson and co-workers recognized that the diagnosis of myocardial infarction was difficult in the presence of LBBB.\(^1\)

In fact, there are few studies dealing with the masquerading effects that LBBB can have on a pre-existing IWMI pattern.\(^2\) The reason probably being the infrequency with which these processes coexist.

Figures 1, 2 and 4 show that increasing degrees of LBBB first reduced and finally obscured the residual QRS evidence of IWMI. These effects can be ascribed to the mode of ventricular activation in LBBB.

More and more contribution from the right ventricular electrical forces (with increasing grades of LBBB) augments the predominance of the activation front moving (from the right endocardial surface) in a leftward, and inferior direction. If the infarction does not extend to the right ventricular endocardium, the q waves in leads 2, 3 and aVF (due to the IWMI) will gradually disappear until being substituted (when LBBB is advanced) by initial positive deflections (r waves) in the same (inferior) leads.

IWMI and LAH

Rosenbaum, Elizari and Lazzari\(^8\) postulated that an IWMI might not be detected in a patient with LAH if the infarction did not involve the ventricular sites first depolarized by the impulse descending through the postero-inferior radiations of the left branch. On the other hand, in both processes a proper diagnosis can be made if the infarction extends to the latter sites. In these cases, as in Figure 3, the initial QRS changes (attributed to IWMI) will coexist with the hemiblock-related left axis shifts.\(^8,23\)

However, the findings noted in Figure 5 were unexpected since LAH abolished the residual changes of IWMI, in the same patient where before (Figure 3) it had not done so. There are several explanations for these paradoxic effects. For instance, they can be related, not to the LAH, but to the RBBB which was present in Figure 3 and absent in Figure 5. This assumption implies that RBBB affected the initial QRS vectors in such a
way as to prevent the appearance of the R waves which would have occurred in leads 2 and 3 if the LAH had been pure. Although conventional electrocardiographic theory holds that human RBBB is manifested (in the surface leads) only during the terminal parts of depolarization, it has long been recognized that excitation arrives at right endocardial surface only slightly after having reached the left ventricular endocardium. It is also possible that, in Figure 5, LAH was associated with a minor degree of LBBB, a process which (as shown in Figure 1, 2 and 4) obscured previous evidence of IWMI. Yet, the existence of a q wave in lead 1 makes this possibility unlikely, unless the LBBB could have produced a change in the initial vectors along the inferosuperior axis before it did so in a left-to-right direction.

Finally, the presence, or absence, of the q waves in leads 2 and 3 (Figures 3 and 5) might be related to the site in which the impulse entered the left ventricle, the latter, in turn, depending on the degree of functional hemiblock.

**LAH and IWMI**

The hallmark of LPH (Fig 6) was an increase of the size of the R waves in leads 2 and 3 which occurred even in the absence of right axis deviation (less than +90°). Since the q waves did not change significantly it appeared that the residual QRS changes of IWMI were less evident when LPH was present.

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