Left Anterior Hemiblock Obscuring the Diagnosis of Right Bundle Branch Block

By Mauricio B. Rosenbaum, M.D., Jacobo Yesurón, M.D., Julio O. Lázziari, M.D., and Marcelo V. Elizari, M.D.

SUMMARY
Three cases in which left anterior hemiblock (LAH) obscured the diagnosis of right bundle branch block (RBBB) are reported. The RBBB was incomplete in one case and complete or of high degree in the other two. The LAH was intermittent in two cases. In the three cases, the LAH abolished not only the S waves in leads I and aVL, but also the terminal R wave in V1.

The possibility that RBBB, complete or incomplete, can be totally missed in the presence of LAH may imply a significant clinical danger, because some of the well known diagnostic and prognostic connotations of this association of conduction disturbances may then be overlooked. However, if the QRS interval is excessively wide or more than expected for pure LAH, the concealed or hidden RBBB can be suspected. It can be readily uncovered if additional unipolar high and right sided chest leads are recorded. The vectorcardiogram can also be helpful, if the possibility of concealed RBBB is kept in mind.

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Concealment of electrical forces

QRS in general, or changes other diagnostic features, is by studying cases in which LAH is intermittent. Indeed, it was the study of two such cases that allowed us to determine that LAH may totally obscure the diagnosis of RBBB. These two cases form the basis of this report. In addition, a third case was studied in which, although LAH was permanent, it was still possible to recognize the coexistence of a concealed form of RBBB.

Case Reports
Case 1. Intermittent LAH Obscuring the Diagnosis of Incomplete RBBB

During the course of a routine examination a 56-year-old man was found to have intermittent LAH and incomplete RBBB. No other clinical or laboratory abnormalities were found. The intermittent, rate dependent LAH is shown in figure IA. Figure IB was prepared in such a way that in every lead LAH is present in the second beat and absent in the first beat. The beats in which LAH is absent show an AQRS around −30°, a QRS duration of 0.10 sec and an incomplete RBBB pattern, with a small slurred S wave in leads I, aVL and V6, and a small terminal R wave in V1. When LAH is present, the AQRS shifts to −60°, the QRS interval remains around 0.10 to 0.11 sec, and the signs of the RBBB are suppressed. Note obliteration of the S waves in leads I and aVL, and of the late R wave in V1. However, the S wave becomes deeper in V6; but this, together with the disappearance of the Q wave from the same lead, belongs in the pattern of LAH.1, 2 In summary, the LAH obscured all the signs of the incomplete RBBB except for the QRS duration.
Otherwise, the changes introduced by the LAH were as reported in a larger series of intermittent LAH. It should also be noted that LAH simulated the presence of left ventricular hypertrophy (LVH) in aVL.

**Case 2. Intermittent LAH Obscuring the Diagnosis of Complete RBBB**

A 67-year-old man was seen in consultation for fainting spells and intraventricular block. RBBB had been present for at least one year. Neurological examination demonstrated that the spells were related to occlusive lesions in the left carotid and verteobasilar arteries. The electrocardiographic study revealed RBBB with intermittent LAH (fig. 2). Figure 3A was prepared in such a way that in every lead the first beat shows LAH (plus RBBB), and the second beat shows RBBB alone. In the beats showing LAH plus RBBB, the AQRS is around −70° and the QRS duration is 0.14 sec. However, no signs of RBBB are seen except for the S waves in the left precordial leads, which can also be attributed to the LAH. In the beats showing RBBB alone, the AQRS is around +60°, the QRS interval again measures 0.14 sec, and the RBBB is clearly seen, with a late R wave in V1 and a slurred S wave in leads I and aVL. LAH seems to obscure totally the signs of the RBBB.

Initially, the tracing was hard to understand, and the first impression was that some beats showed RBBB and some other beats showed LAH (fig. 2), but the two conduction disturbances were never seen together in the same beat. In other words, when RBBB occurred LAH disappeared, and when LAH occurred the RBBB seemed to disappear. Of course, such a completely opposite physiological behavior of two independent conduction problems is extremely unlikely, and the clue to the diagnosis was the fact that the QRS interval did not change from one type of conduction to the other. Indeed, this was the first case in which LAH was shown to totally obscure a complete RBBB pattern. The RBBB was considered to be complete or at least of high degree because the QRS duration remained around 0.14 sec throughout. One year later, the patient developed true Adams-Stokes seizures which required implantation of a pacemaker. At that time, a typical trifascicular block was observed, and the RBBB and LAH were seen

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**Figure 1**

*Case 1. (A) Intermittent LAH. Leads aVL and aVF simultaneously recorded. LAH occurs only in the fourth to sixth beats. (B) In every lead, LAH is absent in the first beat and present in the second beat. LAH obliterates the S waves in leads I and aVL, and the small terminal R wave in V1, obscuring the diagnosis of incomplete RBBB.*

**Figure 2**

*Case 2. Intermittent LAH. Leads II and V1 simultaneously recorded. LAH occurs only in the first two and last two beats. When LAH disappears (beats 3 to 6), a typical RBBB pattern is uncovered.*
CASE 3. PERMANENT LAH OBSCURING THE DIAGNOSIS OF COMPLETE RBBB

A 69-year-old man was hospitalized for Adams-Stokes seizures. An ECG showed LAH and a wide QRS complex (fig. 5A). The AQRS was around −70°, the QRS interval measured 0.15 sec and V1 showed a wide notched Q wave, with small Q waves in V2 and V3. The width of the QRS complex indicated that LAH was complicated by something else, and because of the Adams-Stokes seizures and the QRS notching in V1, “concealed” RBBB was suspected. Chest leads one interspace above and below the conventional level were requested (fig. 5B), and the higher chest leads revealed the unquestionable presence of RBBB. Figure 6 shows the VCG before and after implantation of a pacemaker. It is clear that the RBBB is also greatly or totally obscured in the VCG. In the horizontal plane, there is amputation of the anterior forces and a marked terminal slowing oriented to the right but not anteriorly. Because it does not belong in the pattern of pure LAH, the terminal slowing oriented to the right should be retained as a possible indication of RBBB.

Figure 3

Case 2. (A) In every lead, the first beat shows LAH (plus RBBB), and the second beat shows RBBB alone. LAH suppresses the S waves from leads I and aVL, and the terminal R wave from V1, concealing the presence of complete or high grade RBBB. (B) Additional unipolar chest leads, recorded at a time when LAH was present, as in lead II. A and B indicate one interspace above and below the conventional level.

to alternate with left bundle branch block (LBBB) and paroxysmal atrioventricular (A–V) block in several tracings.

Figure 3A also shows that the LAH obscured the diagnosis of severe LVH in leads V4 to V6, and at the same time uncovered signs of LVH in aVL. The patient has actually had severe LVH, with an extremely large heart at X-ray examination.

When more detailed unipolar exploration of the right side of the chest was performed, a terminal R wave suggestive of RBBB (in the presence of LAH) was recorded, particularly in V1 one interspace above the conventional level (fig. 3B). Figure 4 shows the vectorcardiogram (VCG) recorded both when LAH was present and absent. In the presence of LAH and in the transverse plane, the terminal forces of the RBB become less anterior and to the right. However, the terminal slowing and a slight tendency of the final QRS forces to be oriented to the right are preserved.
Case 3. VCG (Frank) recorded in the presence of RBBB with LAH (left), and after implantation of an artificial pacemaker (right). The only evidence of the RBBB is given by the heavy slowing of the terminal still rightwardly oriented QRS forces. The anterior terminal forces of RBBB have been totally suppressed. H = horizontal; S = sagittal; F = frontal.

Discussion

Different Forms of RBBB Concealment

The fact that LAH can obscure the diagnosis of small degrees of RBBB has been reported, and was confirmed by Case 1 of this paper. However, it was more difficult to conceive that LAH could also mask greatly or totally the diagnosis of complete or high grade RBBB, as exemplified by Cases 2 and 3.

There are several ways in which LAH may obscure the diagnosis of RBBB. Thus, cases have been described in which LAH obliterated the S waves from leads I and aVL. Moreover, it has been demonstrated that, in general, the greater the degree of LAH and the deeper the S waves in leads II and III, the smaller the S waves become in leads I and aVL until total disappearance. When the maximum degree of this change occurs, the final tracing looks like LBBB in the limb leads, but for the presence of the small Q wave in leads I and aVL, due to the LAH. In few cases, when Q1 also disappears (for instance, due to an additional inferior infarction), the resemblance to LBBB is complete in the limb leads. In some of these cases, LAH may also suppress the S waves in V5 and V6, and when this occurs the full tracing looks like LBBB in both the limb and left precordial leads, and like RBBB in the right precordial leads.

The mechanism of these atypical forms of RBBB with LAH has been discussed. Essentially, there is a cancellation of the terminal QRS forces of the RBBB pointing to the right by powerful forces pointing to the left and occurring at about the same moment of the cardiac cycle. Three sources for these forces can be identified: (1) LAH; (2) severe LVH; and (3) focal blocks (infarction or fibrosis block) in the anterolateral wall of the left ventricle, all of which can produce powerful terminal forces oriented to the left. The essential prerequisite for
these factors to cancel out the rightwardly oriented forces of RBBB is that they occur sufficiently late in the cardiac cycle to coincide with the late moments of right ventricular activation. Severe LVH and focal blocks can do this. Accordingly, most cases of masquerading BBB imply an association of the three, or at least two of these factors.

A fourth factor may play an important role in the cases of precordial masquerading BBB, and this is related to the position of the heart or to the strict placement of the chest electrodes. Thus, when powerful forces of vertical direction (oriented either superiorly or inferiorly) are present, the conventional chest leads become extremely sensitive to such forces, in such a way that small displacements of the electrode positioning can evoke extreme QRS changes. For instance, in high grade LAH with extremely deep S waves in leads II and III, chest leads recorded a few centimeters above the conventional level tend to show a predominantly positive QRS complex, whereas leads recorded slightly below display a predominantly negative QRS complex. In some cases of precordial masquerading BBB, it can be shown that the QRS is totally positive in V5 and V6 in the presence of RBBB with LAH, either because the chest leads were recorded slightly above the conventional level or because the heart was vertical.

It is apparently more difficult to visualize that even the anterior terminal forces of RBBB can be "abolished" by LAH, implying that LAH may also produce strong terminal QRS forces oriented posteriorly. This is indeed uncommon, but there is no question that it may happen, particularly in high grade LAH, and when additional powerful left ventricular forces do occur, as caused by LVH and focal blocks. This was apparently the case in the three examples presented in this paper, giving rise practically to a total cancellation of the RBBB pattern.

Clinical and Physiological Implications

It has been known for many years that LBBB may obscure the electrocardiographic diagnosis of several other abnormalities. More recently, it has been shown that the same may occur with hemiblocks, and cases of LAH obscuring the diagnosis of myocardial infarction or other conditions have been reported. However, this seems to be the first time that attention has been called to the fact that LAH may obscure the diagnosis of RBBB. Failure to recognize the RBBB under such conditions can cause clinical error. It is well known that RBBB associated with LAH may herald the occurrence of heart block. Therefore, missing the diagnosis of the RBBB may draw a curtain over such an important clinical implication. In addition, in cases in which the patient has already developed Adams-Stokes seizures and further evidence of A-V block, failure to uncover the concealed RBBB can cause erroneous or extremely difficult interpretation.

When aberrant ventricular conduction of supraventricular premature beats is studied, it can be shown that if progressively premature impulses are introduced, RBBB tends to occur first, followed by LAH. This suggests that, in the normal human heart, refractoriness persists longer in the RBB than in the anterior division of the LBB. However, in certain cases, LAH seemed to appear before RBBB. Under such conditions, exclusion of a small degree of RBBB is difficult because it may be obscured by the LAH, and the conclusion that refractoriness of the anterior division of the LBB may occasionally be longer is hard to prove. This problem has been previously discussed.

When small terminal delays are described in the VCG of "pure" LAH, the possibility that the delay is actually related to a hidden incomplete RBBB should be considered.

Identification of Concealed or "Invisible" RBBB

Left anterior hemiblock, alone or associated with LVH and focal block, may obscure most of the signs of RBBB related to QRS configuration and direction of electrical forces. However, there is no possible way in which any of these factors may diminish an increased QRS duration due to RBBB. Accordingly, in the presence of LAH, an increased QRS duration should be the main clue for suspecting hidden or concealed RBBB.

Pure LAH increases the QRS duration no more than 0.020 sec, thus, a QRS interval longer than 0.10 or 0.11 sec indicates the existence of complicating factors. Severe LVH and focal blocks due to myocardial infarction or fibrosis may be among these factors. RBBB may be the other important cause of excessive QRS widening in the presence of otherwise typical LAH. Under such conditions, the simple recording of additional chest leads one interspace above the conventional level, or slightly to the right of V1, may readily uncover the concealed RBBB. A VCG may also be helpful, by showing a marked terminal delay oriented slightly to the right in the transverse plane.

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MAURICIO B. ROSENBAUM, JACOBO YESURÓN, JULIO O. LAZZARI and MARCELO V. ELIZARI

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