Relationship of Right Bundle-Branch Block and Marked Left Axis Deviation (with Left Parietal or Peri-infarction Block) to Complete Heart Block and Syncope

By Richard P. Lasser, M.D., Jacob I. Haft, M.D., and Charles K. Friedberg, M.D.

The pattern of complete right bundle-branch block (RBBB) combined with abnormal left axis deviation is shown to be the predominant conduction abnormality during orthograde (antegrade) conduction in patients who have experienced transient or permanent complete heart block (59% of a series of 44 patients). Sequential records on the same patient are presented showing progressive development of the complete pattern from left parietal and peri-infarction block alone and also from RBBB with normal axis deviation. Underlying abnormality is a partial bilateral bundle-branch block, that is, complete RBBB and involvement of the anterior-superior subdivision of the left bundle. The incidence of this pattern in 5,500 consecutive hospital records was 1%. Of these, 10% manifested complete heart block. It is suggested that a history of syncope or dizziness in a patient with the above pattern may denote that episodes of transient heart block have occurred.

Additional Indexing Words:
Heart block    Stokes-Adams attacks    Bilateral bundle-branch block    Conduction

Wilson and Associates, in 1934, called attention to an unusual electrocardiographic pattern characterized by a QRS configuration of right bundle-branch block in precordial leads and marked left axis deviation resembling left bundle-branch block in the standard leads (RBBB + MLAD). The abnormal degree of left axis deviation in frontal plane leads distinguished this pattern from isolated right bundle-branch block of the Wilson type. These authors advanced three possible explanations for the abnormal degree of left axis deviation: (1) abnormal electrical position of the heart, (2) a lesion of some of the subdivisions of the left bundle branch, and (3) anterior or septal wall myocardial infarction. No reference was made, however, to a possible relation to complete heart block or to Stokes-Adams syndrome.

Subsequent investigations provided evidence to support the concept that this pattern did represent a form of bilateral, partial bundle-branch block. Thus, histopathological studies of the conduction system in patients displaying this pattern were reported as showing extensive involvement of both left and right bundle branches.2-5 A more specific localization of the conduction abnormality was suggested after the work of Grant4 on the significance of marked LAD. He indicated that marked LAD was attributable to involvement of the anterior-superior division of the left bundle branch. A lesion of this subdivision would alter the sequence of left ventricular depolarization so that terminal forces would be directed superiorly, pro-

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Work was done while Dr. Haft was a U. S. Public Health Research Fellow Trainee.
Producing an LAD of greater than -30° in frontal plane leads without an increase in the QRS duration. The pathology was either diffuse fibrosis or macroscopic infarction of the anterior (superior) portion of the interventricular septum. Grant termed this electrocardiographic pattern "left anterior parietal block" when due to fibrosis alone, and "left anterior peri-infarction block" when due to infarction. Hereafter in our study, this terminology of Grant will be applied to MLAD as it appears in combination with RBBB. The conduction abnormality responsible for MLAD has been reproduced in dogs and even more strikingly in primates by section of the anterior division of the left bundle branch. Thus, the conduction abnormality responsible for the pattern of RBBB with marked LAD may be complete interruption of the main right bundle branch combined with involvement of the anterior-superior division of the left bundle branch. This combination of lesions has been postulated by Lepeschkin and has actually been produced in a dog by Wilson and Herrmann by appropriately placed sections of the two bundle branches.

Only a single study, based on vectorcardiographic analysis, has conflicted with this interpretation. Richman and Wolff, in 1954 proposed that the pattern of RBBB with marked LAD was due to complete left bundle-branch block alone (masquerading block). They believed that left ventricular potentials were being projected on the right side of the chest because of septal and posterior wall myocardial infarction.

The purpose of this communication is to emphasize the frequency with which complete heart block develops and Morgagni-Stokes-Adams attacks occur in patients who have displayed this pattern prior to the development of complete heart block. In other patients who are first seen with complete heart block or Adams-Stokes syndrome, subsequent observations disclosed the distinctive electrocardiographic pattern of RBBB + MLAD when there was a return of orthograde (supraventricular conduction). In addition, electrocardiographic evidence will be offered to support the hypothesis that this pattern is a form of partial bilateral bundle-branch block consisting of complete right bundle-branch block combined with block of the anterior-superior subdivision of the left bundle (left anterior parietal block or "peri-infarction" block).

Methods

Our report is based on the study of two series of cases. One series consisted of 95 patients with documented, chronic, acquired permanent or intermittent complete heart block and Morgagni-Stokes-Adams attacks. We sought to determine the presence of the pattern of RBBB and marked left axis deviation (with either left anterior parietal or peri-infarction block) in records showing antegrade conduction. Beats of supraventricular origin could be identified in 44 of these patients either in records preceding the development of complete heart block, or following recovery from transient block or in capture beats of clearly supraventricular origin. This study does not include any patients with acute heart block occurring secondary to acute myocardial infarction, administration of digitalis, or following cardiac surgery, or of congenital origin.

Another series was accumulated by reviewing 5,500 consecutive hospital electrocardiographic records for the incidence of the pattern of RBBB with marked left axis deviation. Clinical data on these patients were also recorded.

Electrocardiographic Criteria

The following electrocardiographic criteria were employed in the selection of cases for the study:

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Patients</th>
</tr>
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<tbody>
<tr>
<td>Complete right bundle-branch block</td>
<td>26 59</td>
</tr>
<tr>
<td>With marked left axis deviation (left anterior parietal or peri-infarction deviation)</td>
<td>26 59</td>
</tr>
<tr>
<td>Without marked left axis deviation</td>
<td>5 11</td>
</tr>
<tr>
<td>Marked left axis deviation with normal QRS duration</td>
<td>5 11</td>
</tr>
<tr>
<td>Complete left bundle-branch block</td>
<td>4 9</td>
</tr>
<tr>
<td>Normal intraventricular conduction</td>
<td>4 9</td>
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</tbody>
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Right Bundle-Branch Block with Left Anterior Parietal Block

This was considered present when the ECG showed: (1) QRS duration of 0.12 sec or more; (2) mean electrical axis in standard leads more negative than $-30^\circ$; (3) the presence of a small R wave of at least 0.04 sec in duration in leads II and III; (4) QRS configuration in V₁ consisting of a notched R wave, or rR', or rSR', or rsr' complex; and (5) intrinsicoid deflection in lead V₆ of less than 0.06 sec (to exclude main left bundle lesions).

Right Bundle-Branch Block with Left Anterior Peri-infarction Block

This was considered to be present when in addition to the above characteristics, abnormal Q waves were found in precordial leads or leads I and aVF, or in all these leads.
The development of complete heart block in a patient previously manifesting complete RBBB with left anterior parietal block during supraventricular conduction.

Results

The QRS configuration during supraventricular conduction in 44 patients with Adams-Stokes syndrome and advanced or complete heart block is shown in Table 1. Of these 44 cases, 59% (26) showed the pattern of RBBB and marked LAD (that is, with left parietal or peri-infarction block) during orthograde conduction. Among the remaining 18 cases, 11% (5) showed RBBB without marked LAD, 9% (4) showed complete LBBB, 11% (5) marked LAD alone, and 9% (4) showed normal intraventricular conduction during supraventricular conduction.

Figure 1 shows a typical example of the pattern of complete RBBB with left anterior parietal block; (1) QRS duration of 0.15 sec, (2) marked left axis deviation of -59°, (3) rsR' in lead V1, (4) an initial, small R wave of at least 0.04 sec in duration in leads II and III, and (5) intrinsicoid deflection in V6 of less than 0.06 sec.

Figure 2 shows the second variety of the pattern, that is, complete RBBB with left anterior peri-infarction block. This includes abnormal initial vectors (Q waves) in leads I, aVL, and V1 to V5 in addition to the other characteristics of (1) prolonged QRS duration, (2) marked left axis deviation (-86°), (3) qR configuration in V1. The infarction is localized to the anterior and lateral walls. T-wave inversion in leads II, III, aVF and V3 to V6 is consistent with this area of infarction.

Figure 3 shows an example of the pattern of RBBB with marked LAD prior to attacks of intermittent complete heart block, and the record during complete heart block in this
same patient. Figure 4 shows a patient with pacemaker parasystole where capture beats of supraventricular origin can be observed, and these demonstrate the RBBB and MLAD pattern.

The evolution of the complete pattern was followed in three patients in whom separate components of the pattern appeared at different times.

Figure 5 shows two records in the same patient taken 3 months apart. This patient had angina pectoris but no known myocardial infarction. The upper ECG shows, as the sole abnormality, a marked left axis deviation (−48°) which characterizes left anterior parietal block. The lower record, taken 3 months later, shows the addition of complete RBBB without change in axis, forming the complete pattern. This occurred without clinical or electrocardiographic evidence of recent myocardial infarction.

Figure 6 shows the same sequence in a patient whose first record shows marked left axis deviation and Q waves in V1 to V4 indicating left anterior peri-infarction block and anteroseptal wall myocardial infarction. The lower record, some 8 months later, without evidence of fresh infarction, shows the complete pattern of RBBB with MLAD.

Figure 7 shows a different sequence of development of the complete pattern. The patient was known to have complete RBBB with normal axis deviation for many years as shown in the first tracing. The next tracing taken several hours after an attack of acute myocardial infarction shows Q waves in leads aV1, V1 to V4, and marked elevation of the RS-T segment in leads I, aV1, and V1 to V6. The third ECG, taken 2 days later, shows a marked LAD of −86°, in addition to the previous RBBB and anteroseptal wall myocardial infarction. The fact that the marked left axis shift suddenly occurred several days after the infarct is compatible with the development of block of the left anterior-superior bundle branch.

The incidence of the pattern of RBBB with marked LAD, as determined by review of 5,500 consecutive hospital patient records, was 1% (55 patients). Of these 55 patients, five (9%) had third degree heart block and seven (13%) showed first degree block. Significant Q waves indicative of myocardial infarction were observed in 29 cases (53%). Thirteen infarctions were anteroseptal, 12 were anterior, and four anterolateral in location. Clinical data were available for 36 of these 55 patients. Of these, 22 (61%) had histories of atherosclerotic heart disease manifested by myocardial infarction or angina pectoris; nine (25%) had hypertensive heart disease; four (11%) had aortic valve disease and one patient (3%) had primary myocardial disease. Twenty-two per cent of the above patients had diabetes mellitus and 85% showed cardiomegaly.
Progressive development, in the same patient, of the full pattern of complete RBBB with left anterior parietal block from an initial tracing showing only anterior parietal block (upper strip). The occurrence of RBBB (in the lower strip) has widened the QRS complex and added the characteristic $S_i$ and $rR'$ complex in $V_1$ to $V_3$, but has not essentially changed the pre-existent abnormal left axis deviation.

Discussion

The concept of complete bilateral bundle-branch block as a mechanism of complete heart block has been well established on the basis of experimental lesions in dogs and histological studies in man. However, the electrocardiographic diagnosis of bilateral bundle-branch block is still made only infrequently since the criteria usually employed are either alternation of right and left bundle-branch block patterns with varying duration of P-R interval, or a prolonged intrinsicoid deflection in both $V_1$ and $V_6$, though these may not represent all the electrocardiographic patterns of bilateral bundle-branch block. While other patterns of bilateral bundle-branch block are rare, this pattern of RBBB and MLAD which we have studied is common. It has been observed in this study in about $1\%$ of routine hospital records, and in the majority of patients with heart block and Morgagni-Stokes-Adams attacks. Further indication of the close relationship of this particular pattern to complete heart block, in addition to the evidence presented here, can be found if one surveys the earlier literature on this conduction abnormality. Thus, Stokes-Adams seizures occurred in one of three cases reported by Wilson and associates, in two of the three cases reported by Yater and co-workers, in three of the four cases reported by Richman and Wolff, and in the one case studied by Strauss and Langendorf.

It remained for Lenègre to establish the histological proof of the frequency of bilateral
Progressive development of complete right bundle-branch block with anterior peri-infarction block from an initial tracing on 3/17/65 (upper tracing) showing anteroseptal wall myocardial infarction with marked left axis deviation (left anterior peri-infarction block). The lower tracings (6/4/65) now show widening of the QRS complex and the appearance of an S₁ and late R wave in V₁-V₂, indicative of complete right bundle-branch block.

bundle-branch block in patients with heart block, though the pioneer work had already been performed by Mahaim in 1931. Lenègre also noted that the pattern of right bundle-branch block with marked left axis deviation was indeed characterized pathologically by involvement of both bundles often sparing the A-V node completely and was a frequent finding in patients dying of complete heart block.

That marked LAD in these cases does represent a partial block of the left anterior subdivision of the main left bundle of His appears to be supported by our observations, namely: (1) complete heart block has developed in patients previously showing the combination of RBBB with MLAD (left parietal or peri-infarction block), and (2) the combination of RBBB and MLAD has developed in patients who previously showed only RBBB or only MLAD.

The frequency with which right bundle-branch block and involvement of the anterior-superior division of the left bundle occur together is explained by the anatomy of the cardiac conduction system and the septal blood supply. The main left bundle of His is short and in fanlike fashion ramifies quickly.
in the interventricular septum forming first a posterior and then an anterior division. The anterior division of the left bundle branch and the second portion of the unarborized right bundle branch run in close proximity in the anterior (superior) part of the septum and share a common blood supply, that is, the septal branches of the left anterior descending coronary artery. On the other hand, blood supply to the atrioventricular node, common bundle of His, main left bundle branch, and posterior subdivision of the left bundle branch is chiefly from the right coronary artery or occasionally from the circumflex branch of the left. Thus subendocardial or transmural infarction of the anterior portion of the septum may involve both the main right bundle and anterior division of the left simultaneously and spare the main left bundle and posterior division of the left. This relationship was also originally shown by Mahaim.19 The etiology of the conduction impairment in other cases seems to be diffuse fibrosis of the septum and may occur in aortic valve disease, hypertension,16 primary idiopathic myocardial disease,20 alcoholic myocardiopathy,21 and Chagas’ disease.22 This pattern also is well known in congenital heart disease and is seen in a majority of cases of defects of the atrioventricular canal.23 These cases differ from the acquired ones in that the conduction abnormality is likely to be a developmental anomaly24 rather than a pathological change and may therefore not progress to complete heart block.

The risk of developing complete heart block in an unselected series with this pattern is about 10%. It is thus apparent that a high index of suspicion should be maintained in patients with RBBB and marked LAD who complain of transient episodes of dizziness or syncope and an investigation should be initiated to identify transient complete heart block. Instances have already been encountered in the authors’ clinical experience in which this pattern has suggested the true nature of transient neurological abnormalities even though no heart block was apparent when initial electrocardiograms were made.

Figure 7
Progressive development of RBBB with left anterior peri-infarction block from an initial tracing showing RBBB with a normal axis deviation (A). Patient sustained acute myocardial infarction. (Record B) Obtained 5 hours later, this shows acute anteroseptal wall myocardial infarction without change in frontal plane axis. (Tracing C) Taken 2 days later, this record shows a marked left axis deviation of −86° characteristic of left anterior peri-infarction block in addition to the pre-existent RBBB.
Concluding Comment
The electrocardiographic pattern of complete right bundle-branch block with marked left axis deviation (more negative than $-30^\circ$) is by far the most common precursor or attendant of complete heart block. The pattern may occur in two forms, as right bundle-branch block combined with either left anterior parietal block or left anterior peri-infarction block. In both, the underlying abnormality of conduction is believed to be a partial bilateral bundle-branch block, namely, complete interruption of the main right bundle combined with involvement of the anterior-superior subdivision of the left bundle.

The mechanism of development of complete heart block is believed to be bilateral bundle-branch block. Since it is estimated that 10% of patients who acquire this pattern may at some time develop complete heart block and Adams-Stokes syndrome, a history of syncope or transient dizziness in a patient with this pattern may denote that episodes of heart block have occurred.

References
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