A Case of Alternating Bundle Branch Block in Combination With Intra-Hisian Block

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SUMMARY

We describe a 66-year-old woman who had an alternating bundle branch block consisting of coexisting occurrence of right bundle branch block (RBBB) and left bundle branch block (LBBB) combined with Mobitz type II atrioventricular block (AVB). A prolonged PQ interval was associated with the RBBB pattern whereas it was not apparent in the LBBB pattern. Electrophysiologic study revealed that the LBBB pattern was combined with a double His bundle potential. On the other hand, the RBBB pattern was combined with a markedly prolonged HV interval with a low voltage monophasic His bundle potential, which we speculated was the former part of the split His bundle potential seen during the LBBB pattern. A combination of the longitudinal dissociation in the His bundle and the gap phenomenon at the intra-Hisian block portion may account for this observation. (Int Heart J 2005; 46: 737-744)

Key words: Alternating bundle branch block, Intra-Hisian block, Longitudinal dissociation in the His bundle, Gap phenomenon

ALTERNATING bundle branch block (ABBB) is an unusual conduction disturbance consisting of coexisting or alternating occurrence of right bundle branch block (RBBB) and left bundle branch block (LBBB).1-3) We present a variant case of ABBB that consisted of sequences of normal QRS complex, LBBB, RBBB, and atrioventricular block (AVB). Electrophysiologic study demonstrated an intra-Hisian block associated with RBBB and LBBB.

CASE REPORT

A 66-year-old woman was admitted to our hospital with complaints of worsening dyspnea, palpitations, and chest pain on exertion over the preceding month.

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Figure 1. ECG on admission demonstrating normal sinus rhythm (62/minute), normal axis (15 degrees), PR interval of 0.16 seconds, and a normal QRS waveform.

Figure 2. ECG showing complete LBBB pattern on chest lead.
The patient had a history of diabetes that was diagnosed 20 years previously for which she was receiving insulin therapy. The patient was also diagnosed with hyperlipidemia for which she was receiving statin therapy. Her family history was significant since her father had died of a myocardial infarction at 42 years of age.

On admission, her blood pressure was 132/56 mmHg, and her heart rate was regular at 66/minute. A 3/6 systolic murmur was present at the right sternal border. A chest X-ray demonstrated slight enlargement of the cardiac silhouette (CTR 54.2%) with clear lung fields. Laboratory testing revealed a low serum HDL concentration and indicated a state of poor glycemic control with an HbA1c value of 8.9%.

An ECG on admission demonstrated normal sinus rhythm (62/minute), a normal axis (15 degrees), a PR interval of 0.16 seconds, and a normal QRS waveform (Figure 1). However, during the course of the hospitalization, patterns of complete LBBB (Figure 2) and complete RBBB (Figure 3) were also recorded, consistent with a diagnosis of ABBB. Although a normal PQ interval accompanied the LBBB pattern, first degree AVB with a PR interval of 0.22 seconds was present with the RBBB pattern.

Two sequences of monitor ECG recordings during hospitalization are illustrated in Figure 4. On the ECG with a P rate of 86/minute (top), QRS complexes with a deep S wave, suggesting an RBBB pattern, with a prolonged PQ interval of

![Figure 3. ECG showing complete RBBB pattern. Note combination of first degree AVB with a PR interval of 0.22 seconds.](image-url)
**Figure 4.** Two sequences of monitor ECG recorded during hospitalization. Top: ECG with a P rate of 86/minute demonstrating coexistence of QRS complexes with deep S waves, suggesting an RBBB pattern, with a prolonged PQ interval of 0.24 sec, LBBB pattern, and AVB. Bottom: ECG with a P rate of 94/minute showing a 2-to-1 AVB.

**Figure 5.** His bundle electrogram during normal QRS and LBBB appeared spontaneously on body surface ECG. The AH and HV intervals were within normal limits (AH = 70 ms, HV = 40 ms) during normal QRS pattern (A). However, a split His bundle potential pattern (HH'; indicating intra-Hisian block, arrow) with a prolonged HV interval of 70 ms was recorded during the LBBB pattern (B).
0.24 sec were observed on the 2nd, 5th, and 10th beats, and P waves without QRS complexes were observed on the 3rd and 11th beats, mimicking a Wenckebach cycle. On the same recording, an LBBB pattern was observed on the 6th and 7th beats, followed by a QRS defect without a prolonged PQ interval. A 2-to-1 AVB with a P rate of 94/minute was also observed (bottom).

An electrophysiologic study was performed with a quadripolar catheter placed in the high right atrium (HRA) for pacing, and an octapolar catheter across the tricuspid valve for His bundle recording. Normal QRS and LBBB appeared spontaneously on the body surface ECG without HRA pacing (Figure 5). The AH and HV intervals were within normal limits (AH = 70 ms, HV = 40 ms) during normal QRS patterns. However, a pattern of split His bundle potential (HH'; indicating an intra-Hisian block) with a prolonged HV interval of 70 ms was recorded during the LBBB pattern, thereby resulting in a slight prolongation of the AV interval (140 ms) in comparison with that during a normal QRS pattern (110 ms). Three ECG patterns, ie, normal QRS, LBBB, and RBBB, were recorded using a single extrastimulus method with a basic cycle length of 90 bpm (Figure 6). Although similar AV conduction patterns were obtained during the normal QRS and LBBB patterns, the HV interval was markedly prolonged (205 ms) during the

![Figure 6](image-url). Three ECG patterns, ie, normal QRS, LBBB, and RBBB recorded using a single extrastimulus method with a basic cycle length of 90 bpm. Note that the HV interval was markedly prolonged (205 ms; indicated by bar) during the RBBB pattern, and the His bundle potential was of a single deflection type and relatively low voltage (arrow) when compared with the normal ECG tracing. After the 2nd and 4th pacing spikes, an AH combination without ventricular activity was recorded. After the 4th excitation with block, conduction of the His-Purkinje system would have recovered from the refractory period, and therefore the 5th spike could yield a normal QRS pattern.
The RBBB pattern, and the His bundle potential was of the single deflection type and relatively low voltage when compared with a normal ECG tracing (right side). After the 2nd pacing spike, an AH combination without ventricular activity was recorded.

The appearances of the bundle branch block patterns, the AH and HV interval values, and the appearance of the split His pattern are summarized in the Table. The LBBB pattern was present at each HRA pacing rate, and the RBBB pattern was present only at pacing rates of 90 and 150 bpm. A relatively long HV interval was obtained during the RBBB pattern.

A left ventriculogram was normal with an ejection fraction of 75.7%, and a coronary angiogram revealed normal coronary anatomy.

Thus, this patient was diagnosed with ABBB combined with Mobitz Type II heart block. Because of the possibility of progressing to complete AVB, we elected to undertake permanent pacemaker implantation.

**DISCUSSION**

A diagnosis of ABBB is based on two different definitions.\(^2,^4\) The first is that RBBB and LBBB patterns must be present on the same ECG recording, while the second definition states that the two patterns may occur with some degree of temporal separation (ie, hours or days apart). In a series of patients described by Rosenbaum,\(^5\) only 3 of 11 patients with ABBB demonstrated RBBB and LBBB on the same ECG. The present case satisfied the first definition by demonstrating both patterns on a single ECG strip (top of Figure 4 and Figure 6).
Unique features of the present case include a predominance of the LBBB pattern over the RBBB pattern and an association of first-degree AVB with the RBBB pattern. In contrast, previous cases have demonstrated a predominance of the RBBB pattern with a longer HV interval during the LBBB pattern. An electrophysiologic study of the present case revealed that the split His bundle potential was only observed during the LBBB pattern and that the HV interval was maintained. However, a single, lower His bundle potential was present during the RBBB pattern, and the HV interval was prolonged; this may reflect detection of the former part of the split His bundle potential during the RBBB pattern.

Wu, et al proposed that ABBB resulted from the difference in refractory period of both bundle branches, while Bisset suggested that ABBB was caused by the gap phenomenon. A longitudinal dissociation of the His bundle has been documented by Ahmed, et al and may account for ABBB in the present case (Figure 7). During LBBB, a conduction delay occurs at the intra-Hisian fiber that gives rise to the left bundle branch (one of the sub-bundles caused by longitudinal dissociation), which yields the dual His recordings. In this situation, the conductions of the intra-Hisian fibers that give rise to the right bundle branch (another of the sub-bundles) are normal, and first-degree AVB does not occur (Figure 7B). During RBBB, additional conduction delay occurs at the right bundle system, and the intra-Hisian fibers that give rise to the left bundle are completely blocked, abolishing the latter part of the split His potential. In this situation, conduction of the distal part of the left bundle branch is recovered by the delayed right bundle system with a gap phenomenon. There still exists an additional conduction delay delay.
in the distal right bundle branch after an excitation towards the left bundle branch is produced, which yields a relative delay of the right bundle branch area to the left bundle branch area. Thus, a long HV interval with first degree AVB and an RBBB pattern can appear. However, a bridging conduction between the distal portion of the longitudinal dissociation (ie, common pathway) is required for the gap phenomenon (Figure 7C). When the right and left bundle systems are both blocked, the QRS complex drops out, and second degree AVB occurs (Figure 7D). This is consistent with the data observed in the present case; ie, a normal waveform, LBBB pattern with a normal PQ interval, an RBBB pattern with first degree AVB, and second degree AVB.

In this patient, the underlying myocardial disturbance producing the conduction disturbance in the His-Purkinje system is not clear. Coronary angiogram failed to demonstrate significant coronary artery disease and no evidence of amyloidosis or sarcoidosis was present. However, occult coronary microcirculatory disease cannot be discounted, particularly in the context of longstanding diabetes mellitus.

In summary, we have described a case of ABBB consisting of sequences of normal QRS complexes, LBBB, RBBB, and second degree AVB. A combination of longitudinal dissociation in the His bundle and the gap phenomenon likely accounts for this observation.

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