CASE REPORTS

QRS Alternans with 2:1 Atrioventricular Conduction Block: What Is the Mechanism?

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An 81-year-old woman was admitted for symptomatic bradycardia. On admission, the ECG exhibited QRS alternans, narrow QRS complex and left bundle branch block with 2:1 AV block. The patient soon had complete AV block and underwent a pacemaker implantation. An appropriate mechanism for explaining those ECG findings might be 4:1 conduction over the left bundle branch and 2:1 conduction over the right bundle branch. An ECG pattern exhibiting QRS alternans with a narrow QRS complex and bundle branch block with 2:1 AV block may suggest the coexistence of both bundle branch blocks and a high risk of complete AV block.

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CASE PRESENTATION

An 81-year-old woman with a history of a symptomatic bradycardia was admitted to a local hospital. On admission, the 12-lead electrocardiogram (ECG) exhibited normal sinus rhythm (cycle length 720 ms) and QRS alternans with 2:1 atrioventricular (AV) conduction block (Fig. 1). The QRS alternans consisted of a narrow QRS complex and wide QRS complex with a left bundle branch block (LBBB) morphology and the PR interval (220 ms) was identical in both QRS morphologies. What is the mechanism of this abnormal rhythm?

DISCUSSION

If the second-degree conduction block within the AV node progresses to a complete block, a stable junctional escape rhythm with a decent rate may be expected, whereas if that within the infranodal region progresses to a complete block, a very slow and unreliable ventricular escape rhythm could

lead to a medical emergency. Therefore, when second-degree AV conduction block is observed, the prediction of the site of the conduction block from the ECG is very important for determining the therapeutic strategy. However, when 2:1 AV conduction block is observed, the prediction may be difficult. In this case, at first, Mobitz type I AV conduction block secondary to taking β -blockers was suspected as the cause of her syncope. Therefore, the patient was followed with discontinuation of this medicine. Unfortunately, that initial care involved a common mistake¹ and soon after admission, the patient developed a syncopal episode and complete AV block was documented. The patient was then referred to our institute and she underwent a DDD pacemaker implantation.

In this case, the QRS alternans with a narrow QRS complex and LBBB observed together with 2:1 AV conduction block could have been caused by two different mechanisms. The first possible mechanism is 4:1 conduction over the left bundle branch and 2:1 conduction over the right bundle branch.

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Figure 1. Twelve-lead electrocardiograms exhibiting QRS alternans consisting of a narrow QRS complex and left bundle branch block with 2:1 atrioventricular (AV) conduction block. The P waves in the cardiac tracing were numbered in order of appearance.

The second possible mechanism is 2:1 conduction block at the AV node or proximal His bundle (HB) with 2:1 conduction block at the left bundle branch. In the first mechanism, the P waves would conduct through the His canal. However, P wave numbers 1 and 5 conducted over only the right bundle branch

to the ventricle, and P wave numbers 3 and 7 conducted over both bundle branches to the ventricle. P wave numbers 2, 4, 6, and 8 were blocked because conduction block of both bundle branches occurred simultaneously. In the second mechanism, 2:1 AV conduction block might have occurred due

Figure 2. Twelve-lead electrocardiograms exhibiting right bundle branch block with Mobitz type II AV conduction block. The P waves in the cardiac tracing were numbered in order of appearance. The PR intervals are given in the figure.

to conduction block within the AV node or HB. P wave numbers 2, 4, 6, and 8 were blocked at the AV node or proximal HB level whereas P wave numbers 1, 3, 5, and 7 conducted through the His canal to the ventricle. Though P wave numbers 1, 3, 5, and 7 reached the left bundle branch (the other P waves were blocked at a more proximal level), only P wave numbers 1 and 5 conducted with an LBBB. Therefore, there was also 2:1 conduction block in the left bundle branch during the AV conduction, which could be considered as phase IV (bradycardia-dependent) block.

In this case, a right bundle branch block (RBBB) QRS morphology with Mobitz type II AV conduction block was also observed on admission to our institute (Fig. 2). Only P wave numbers 1 and 5 immediately after the AV conduction block conducted to the ventricle with a narrow QRS, and the other P wave numbers 2 and 3 and 6 to 9 conducted to the ventricle with an RBBB. One could argue that phase III (tachycardia-dependent) block of the right bundle branch occurred after the P waves with the shorter cycle length, and the relatively long pause created by the blocked P wave allowed the right bundle branch to recover for the following P waves. However, that would not explain the changes in the PR interval that are also apparent in Figure 2. Decremental conduction at the level of the AV node plus phase III block of the right bundle branch may be one explanation for that phenomenon. However, if that was the case, one would expect the PR interval to keep enlarging for the following consecutive conducted P waves. Yet, the PR interval increases between only the first two conducted beats, and then remains constant. Therefore, we believe that there should have been a Wenckebach-type conduction block at the infranodal level. The first P waves immediately after the AV conduction block conducted to the ventricle with a slightly prolonged PR interval and narrow QRS complex. The subsequent P waves conducted to the ventricle with increasing degrees of decremental conduction along the His fibers. This decremental conduction probably occurred in the fibers committed to the left and right bundle branches (at the HB level) with

different degrees of severity. Thus, similar degrees of conduction slowing at the right and left bundle branch fibers led to an increment in the PR interval and a narrow QRS. For the subsequent P waves, the decremental conduction became much greater in the right bundle branch fiber than in the left bundle branch fiber, resulting in the occurrence of an RBBB. Eventually, the decremental conduction worsened also in the left bundle branch fibers and simultaneous conduction block of the right and left bundle branch fibers (at the HB level) led to an AV conduction block. Furthermore, it is very rare to see 4:1 conduction anywhere in the conduction system (except for physiologic AV nodal block during atrial flutter). Those considerations might favor the second mechanism with a conduction block at the HB level which explains the QRS alternans with 2:1 AV conduction block though it is challenging to say which of the proposed mechanisms is correct without intracardiac recordings. It is known that the coexisting or alternating occurrence of RBBB and LBBB strongly predicts an occurrence of complete AV block and alternans of those may suggest the worst prognosis independent of the results of electrophysiologic testing.²⁻⁴ Actually, in this case, the first ECG did not exhibit both RBBB and LBBB. However, whichever of the two above mechanisms was true, an ECG pattern exhibiting a QRS alternans consisting of a narrow QRS complex and RBBB or LBBB with 2:1 AV conduction block may suggest a serious infranodal disease and an obvious need for a pacemaker implantation.

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