Understanding Atrioventricular Blocks, Part I:  
First-Degree and Second-Degree Atrioventricular Blocks

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The electrocardiographic diagnosis of AV blocks presents a challenge to health care professionals who monitor cardiac rhythms. Much of the confusion exists as a result of differing definitions of the “degrees” of AV blocks in the literature, especially surrounding second-degree block. Many misconceptions exist about the definitions of type I and type II blocks and how these “types” differ from the “degrees” used in the AV block classification system. Additional sources of confusion and difference of opinion are (1) the concept of 2:1 conduction and (2) where to put blocks that involve failed conduction of 2 or more consecutive P waves. With this much uncertainty and difference of opinion among the experts, it is no wonder that instructors have a hard time explaining and teaching these concepts to students in cardiac arrhythmia interpretation classes.

The term heart block or AV block refers to the problems associated with the conduction of an electrical impulse from the atria to the ventricles. The conduction can be delayed, intermittent, or absent. The classification system typically used to describe these “degrees” of conduction delay is still widely used in textbooks:

First-degree AV block (delayed conduction)  
Second-degree AV block (intermittent conduction): type I and type II  
Third-degree or complete AV block (absent conduction)

Marriott2 stated that the division into 3 degrees is too simple and proposed a much more detailed classification system to describe AV conduction disturbances. Although his very detailed categories have not caught on, the following expanded classification of AV blocks is an attempt to clarify some of the confusion surrounding the subject and is used in this issue:

First-degree AV block  
Second-degree AV block  
- Type I  
- Type II  
- 2:1 conduction

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This article begins a 2-part series on atrioventricular (AV) blocks in an attempt to clarify some of the misconceptions and misinformation that surround the electrocardiographic recognition of AV conduction disturbances. Part I covers first-degree and second-degree AV blocks. Part II will cover high-grade and third-degree AV blocks.
High-grade (or advanced) AV block
Third-degree (complete) AV block

This expanded classification system better defines the “degrees” of AV blocks, which are meant to describe the severity of the conduction disturbance. The term type (ie, type I and type II) refers to the ECG pattern associated with different behaviors of PR intervals prior to and following blocked P waves.1 Atrioventricular conduction can fail anywhere along the conduction system, including in the AV node, bundle of His, and bundle branches. A type I block usually, but not always, occurs in the AV node (intranodal block); a type II block is always below the AV node (infranodal block).1–4

First-Degree AV Block
In a first-degree AV block, there are actually no “blocked” impulses; they all conduct to the ventricle and just take longer than normal to do it. This appears on the electrocardiogram (ECG) as a prolonged PR interval of longer than 0.20 seconds. This PR interval is not necessarily abnormal in persons with high vagal tone or in athletes who have sinus bradycardia as their normal rhythm. A question that often arises is how long a PR interval can be and still represent conduction from the atrium to the ventricles. Rusterholz and Marriott5 published an article titled “How Long Can the P-R Interval Be?” in which they illustrate PR intervals as long as 1 second or more. Figure 1 shows a first-degree AV block with a PR interval of 0.52 seconds.

A first-degree block with a narrow QRS complex occurs in the AV node in more than 90% of cases.2 A long PR interval with a wide QRS complex usually involves delay in the AV node as well, but infranodal delay in the His-Purkinje system can sometimes cause a first-degree block. In the presence of left bundle branch block, a first-degree AV block could represent conduction delay either in the AV node or in the right bundle branch. A first-degree AV block in the presence of a bifascicular block (right bundle branch block with block in either the anterior fascicle or the posterior fascicle) could indicate conduction delay either in the AV node or in the remaining fascicle.3

Second-Degree AV Block
A second-degree AV block involves failed conduction of one P wave at a time from the atrium to the ventricles. Conduction can fail either in the AV node or in the His-Purkinje system. A type I block usually occurs in the AV node and presents with characteristic Wenckebach behavior. A type II block always occurs below the AV node. The older terms, Mobitz I and Mobitz II, are rarely used today.

Type I Second-Degree Block (Wenckebach)
In a type I second-degree block, or Wenckebach conduction, one P wave at a time is blocked almost always in the AV node but occasionally either in the bundle of His or in the bundle branches. Typical Wenckebach conduction appears on the ECG with the following characteristics:

1. Progressive prolongation of the PR interval on consecutively conducted atrial impulses until 1 P wave is blocked.
2. The largest increase in PR interval occurs between the first and the second beats in the cycle; subsequent PR intervals get progressively longer but by smaller increments.
3. R-R intervals get progressively shorter before the blocked P wave.
4. The pause produced by the blocked P wave is less than twice the length of any other cycle in the sequence.
5. The PR interval preceding the blocked P wave is longer than the PR interval following the blocked P wave.
6. The QRS complex is usually narrow, unless a bundle branch block is present.
7. The overall appearance of Wenckebach is “group beating,” with groups of beats separated by pauses.

PR intervals get progressively longer on consecutively conducted beats but by smaller

Figure 1: A first-degree atrioventricular block with PR intervals of 0.52 seconds.
increments each time. This causes the R-R intervals to become shorter before the blocked P wave. Figure 2 illustrates this concept.

A Wenckebach conduction ratio is described in terms of the number of P waves in comparison with the number of QRS complexes that result from these P waves, or P:QRS. There is always 1 more P wave than QRS complexes in a Wenckebach cycle. Figure 3a shows a conduction ratio of 3:2; there are 3 P waves but only 2 QRS complexes in a cycle, resulting in groups of 2 beats separated by pauses. In Figure 3b, a conduction ratio of 8:7 is shown.

Wenckebach cycles are not always consistent in that conduction can vary in the same patient from 3:2 to 5:4 to 6:5, etc. In addition, there are several types of atypical Wenckebach conduction cycles that often occur at longer conduction ratios. Examples of atypical Wenckebach cycles include the following: (1) the second conducted PR interval in the cycle may not show the greatest increment; (2) PR intervals in long conduction sequences may remain constant for several beats before the progressive increase in PR interval occurs; (3) PR intervals may shorten and then lengthen before the blocked P wave; and (4) the last PR interval in the cycle may increase in length more than expected. Even in these atypical cycles, the PR interval preceding the blocked P wave is always longer than the PR interval following the blocked P wave in a Wenckebach cycle.

Type II Second-Degree AV Block

In a type II second-degree AV block, one P wave is blocked below the AV node, either in the bundle of His or in the bundle branches. Block occurs in the bundle of His in approximately

![Figure 2: A ladder diagram of a typical Wenckebach cycle illustrating progressively increasing PR intervals and progressively decreasing R-R intervals. Levels of the diagram are as follows: A, atria; AV, AV node; V, ventricle. Lines in the A level represent the sinus rhythm conducting through the atria. Solid lines in the AV level and in the V level represent the conduction of the current beat in comparison with the dotted lines representing the conduction of the previous beat. Shaded numbers in the AV level are the PR intervals of each beat, whereas unshaded numbers are the PR intervals of the preceding beat. Numbers at the bottom of the diagram show the difference between the current PR interval and the preceding PR interval; note that each consecutive PR interval increases but by a decreasing interval each time, which causes the R-R interval to shorten before the blocked P wave.](image1)

![Figure 3: (a) A second-degree atrioventricular block, type I (Wenckebach), with 3:2 conduction. Sinus rate is 56 beats per minute. The first PR interval is 0.18 seconds, the second PR interval is 0.30 seconds, and the third P wave is blocked. Note that groups of 2 beats are separated by pauses. (b) Wenckebach with 8:7 conduction ratio. Sinus rate is 107 beats per minute. Consecutively conducted PR intervals are 0.13, 0.18, 0.22, 0.24, 0.26, 0.27, and 0.29 seconds, respectively. The largest increase in PR intervals occurs between the first and the second beats in the cycle.](image2)
20% of cases, but most cases of type II block are a manifestation of bilateral bundle branch block in which one bundle branch is permanently blocked and the other intermittently fails to conduct. Type II second-degree block has the following ECG characteristics:

1. One P wave at a time is blocked.
2. PR intervals remain constant before and after the blocked P wave and on consecutively conducted beats.
3. The QRS complex is almost always wide because the block occurs below the AV node in the bundle branch system.

Figure 4 illustrates a type II second-degree block. Multiple P waves in a row conduct with a constant PR interval and a wide QRS complex. Only one P wave at a time is blocked. The wide QRS complex is typical for a type II block occurring in the bundle branches.

One of the misconceptions commonly taught is that whenever the conduction ratio is a fixed ratio (e.g., 2:1, 3:1, 4:1), it is automatically a type II block. The “type” of block describes the ECG pattern that occurs on consecutively conducted P waves, and because there are no consecutively conducted P waves in these fixed conduction ratios, it is impossible to tell for sure what type of block it is unless 2 consecutively conducted P waves occur. In addition, a block could occur in the AV node or below the AV node, and without intracardiac His bundle recordings, it is not possible to tell for sure where the conduction fails.

2:1 Conduction
By definition, a 2:1 conduction ratio is a second-degree block because only one P wave at a time fails to conduct. One of the problems with the 2:1 conduction ratio is that there are no consecutively conducted P waves; therefore, the typical Wenckebach behavior of progressive PR interval prolongation on consecutively conducted beats is not seen. This is why many of us learned to call all 2:1 conductions type II blocks because of the constant PR intervals. However, 2:1 conduction can be a result of

![Figure 4](image-url)

**Figure 4:** A type II second-degree atrioventricular block. One P wave at a time is blocked, but all PR intervals are constant at 0.16 seconds. The QRS complex is wide, typical of a type II block.

![Figure 5](image-url)

**Figure 5:** (a) A second-degree atrioventricular block with 2:1 conduction. The PR interval is 0.20 seconds and the QRS width is 0.10 seconds. The narrow QRS width favors an intranodal site of the block. (b) Same patient with 3:2 and 2:1 conduction ratios. Note that progressively increasing PR intervals on consecutively conducted P waves and the longer PR interval preceding the blocked P wave in comparison with the shorter PR interval following the blocked P wave. This is a typical Wenckebach or type I, cycle.
block in the AV node or below the AV node, and without intracardiac recordings, it is not possible to tell for sure where the block occurs. The following are some ECG clues as to the location of the block in 2:1 conduction:

1. A narrow QRS complex is usually indicative of a block in the AV node, because block below the AV node typically results in a wide QRS complex (unless the block is in the bundle of His).
2. A long PR interval on conducted beats is more likely to indicate a block in the AV node, whereas a normal PR interval on conducted beats occurs more often with an infranodal block.
3. A wide QRS complex is not helpful because this could result from a block below the AV node (type II) or from a block in the AV node with a coincidental bundle branch block that widens the QRS complex.
4. The best ECG clue as to the location of a block in a 2:1 conduction ratio is to observe what happens to PR intervals on consecutively conducted beats should they occur.

Figure 5a shows 2:1 conduction with a narrow QRS complex and a PR interval on conducted beats of 0.20 seconds. Block in the AV node can be inferred because of the narrow QRS complex. In Figure 5b, conduction of 2 P waves in a row occurs, demonstrating typical Wenckebach conduction with progressively prolonging PR intervals on consecutively conducted beats, or type I block. The change in conduction ratio from 3:2 to 2:1 in Figure 5b does not represent a change in the “type” of block; it merely represents a change in the conduction ratio.

Figure 6a shows 2:1 conduction with a wide QRS complex. This could be either an infranodal block or an intranodal block with bundle branch block. In Figure 6b, conduction of multiple P waves in a row occurs with constant PR intervals, demonstrating a type II conduction pattern that indicates a block below the AV node.

Summary
The following statements clarify some common misconceptions regarding the first- and second-degree AV blocks:

1. No “upper limit” exists for a believable PR interval in a first-degree AV block. PR intervals exceeding 1 second have been reported.
2. In a second-degree AV block, only one P wave at a time fails to conduct. (Part II of this series will discuss blocks of more than 1 consecutive P wave.)

3. The “type” of block describes the ECG pattern of behavior of consecutively conducted P waves prior to and following blocked P waves. It does not refer to the location of the conduction failure (intranodal vs infranodal). However, a type I block usually occurs in the AV node, whereas a type II block always occurs below the AV node.

4. Not all 2:1 conductions are type II blocks. If the block occurs in the AV node, it usually demonstrates a typical Wenckebach (type I) conduction pattern when consecutive P waves conduct.

References