

Notes on “Multilevel Atrioventricular Block” – Kosowsky

Type A (Avg. Rate = 284)

$\frac{\text{INTEGRAL}}{\text{INTEGRAL}}$	$\frac{\text{INTEGRAL}}{\text{NON-INTEGRAL (WENCKEBACH)}}$
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1. By definition, the upper level is always an integral ratio which means 2:1 block
2. If the lower level manifests Wenckebach conduction, the episode will end with THREE non-conducted P waves. Just look for the pauses and see if there are three dropped beats. If so, the middle beat is the P wave in the Wenckebach episode that failed to conduct.
3. If the lower level is another 2:1 block, the ECG will manifest a regular 4:1 block.
4. There will *always* be 3 consecutive non-conducted P waves whether an integral or a non-integral block is present in the lower level.

Type B (Avg. Rate = 162)

1. By definition, the upper level is always a non-integral ratio, which means Wenckebach.
2. Whenever you see a 2:1 block with alternating P-R and R-R intervals, think of a Type B multilevel AV block.
3. When an atrial beat is blocked high (in the 1st level), that allows time for the AV pathways to fully recover and the next atrial beat will conduct with the shortest P-R interval. Consequently, this will shorten the R-R interval.

INTEGRAL RATIOS IN THE LOWER LEVEL

$\frac{\text{EVEN \# WENCKEBACH}}{\text{INTEGRAL (2:1)}}$

1. Non-conducted beats will coincide
2. Wenckebach episode will terminate with just ONE non-conducted P wave
3. Both levels recover fully so the subsequent P-R interval is the shortest which creates a paradoxical narrowing of the R-R interval surrounding the non-conducted P wave

ODD # WENCKEBACH

INTEGRAL (2:1)

1. Dropped beat at the upper level follows a non-conducted beat at the lower (2:1) level resulting in **TWO** consecutive non-conducted P waves

NON-INTEGRAL RATIOS (WENCKEBACH) IN BOTH LEVELS

WENCKEBACH 3:2

WENCKEBACH 5:4

1. **Greater degree of block in the upper level** will control the rhythm
2. Will display as a simple 3:2 Wenckebach episode
3. We really do not need to consider this possibility since it cannot be distinguished from a simple, one-level Wenckebach episode on the ECG.

WENCKEBACH 5:4

WENCKEBACH 3:2

1. **Lesser degree of block** in the upper level
2. When the Wenckebach episode in the lower level terminates first, there will be a dropped atrial beat but the next P-R interval will still be prolonged.
3. That is your first hint that there are two levels of Wenckebach conduction and the upper level is displaying a lesser degree of block than the lower level.
4. When the Wenckebach episode in the upper level ends and the block appears, the block will reset ALL the levels and the subsequent P-R interval will be short.
5. If the two Wenckebach episodes differ by just one beat, there will be **TWO** consecutive non-conducted P waves.
6. The Wenckebach episode in the upper level will be the longer of the two episodes. *The longer the episode, the less the block.* Less block allows more beats to conduct before finally blocking.

ODD # WENCKEBACH

INTEGRAL (2:1)

WENCKEBACH 5:4

WENCKEBACH 3:2

Since both of the above combinations can result in TWO consecutive non-conducted beats, how does one distinguish them?

The **ODD # Wenckebach** will be an **alternating Wenckebach**, with an atrial depolarization between each conducted beat. The **Wenckebach 5:4** will show a progressive prolongation of the P-R interval with every beat since no P waves are dropped until the end of each Wenckebach period. The P-R interval after the first pause (end of the 3:2 sequence) will NOT have returned to its normal duration but will still be prolonged because the 5:4 sequence has not yet ended.

How To Determine the Type and Level of the AV Block

1. If the atrial impulses are "F" (flutter) waves, remember that the F wave closest to the QRS is not likely to be the one that conducted, but instead it is usually the penultimate F wave. If the atrial impulses are in the form of P waves, the P wave preceding the QRS should be considered the one that conducted as long as the P-R interval is normal or prolonged a bit. It cannot be shorter.
2. Find the atrial impulse that conducted, producing a QRS complex.
3. Note the remaining atrial impulses that failed to conduct to the ventricles. Remember that not two consecutive atrial impulses block in the same level.
4. An atrial impulse that blocks in the 1st level is usually followed by an atrial impulse that conducts all the way to the ventricles. This is because blocking in the upper level allows the rest of the AV levels to recover. The only time that an atrial impulse that is blocked in the 1st level is NOT conducted on through to the atria is when there are three levels of block and there are four consecutively blocked P waves. Designating the block to be in the 1st level prevents having two consecutive impulses blocked in the same level.
5. When there is a **Type B** AV block with a 2:1 block in the lower level, the Wenckebach cycles terminate with a SHORT R-R INTERVAL (no pause) and NO EXTRA NON-CONDUCTED ATRIAL IMPULSES if the non-integral sequence has an even number of

beats. This is because the non-conducted atrial impulse of the Wenckebach sequence coincides will always coincide with the non-conducted beat of the 2:1 conduction.

6. As the Wenckebach sequences get longer and longer, the last R-R interval will get shorter and shorter. This is because the final non-conducted atrial impulse will block in the 1st level which allows the rest of the AV node and conducting system to recover, making the next P-R interval the shortest. It's the shortening of the P-R interval that shortens the R-R interval.
7. Regarding **Type B**: If there are an EVEN number of atrial beats in the Wenckebach sequence with 2:1 block in the lower level, the R-R interval surrounding the P wave dropped at the upper level will be the shortest of the entire cycle and there are no additional dropped beats.
8. Whenever there appears to be a 2:1 block but the R-R intervals are alternating in duration (group beating), there is a multilevel AV block involving a Wenckebach cycle.

Notes on Multilevel AV Blocks...

The only multilevel AV blocks that will have a **regular ventricular rhythm** will be

Type A that consist only of integral ratios in ALL levels, and

Type B with 3:2 in the upper level and 2:1 in the lower level(s).

Oddities and thoughts:

3:2 / 2:1 / 2:1 - would result in a regular 6:1 AV block

2:1 / 2:1 / 2:1 - would result in a regular 8:1 AV block

2:1 / 2:1 / 4:3 – would result in a regular 8:1 AV block

Type A Blocks with Non-Integral Ratios in the Lower Level

There will always be a non-conducted atrial impulse (F or P wave) between each conducted atrial impulse. The only time there will be multiple non-conducted atrial impulses occurring consecutively will be at the end of the Wenckebach sequence in the lower level when there will be THREE consecutive non-conducted atrial impulses. The

middle non-conducted impulse will be the one that actually terminates the Wenckebach sequence.

Non-integral ratios in ANY level can switch back and forth, so don't expect any long sequences of the same rhythm. Regardless of the non-integral ratio, if there is 2:1 block in the upper level, there will ALWAYS be THREE consecutive non-conducted beats.

$\frac{2:1}{3:2}$ } Groups of two QRS complexes separated by 3 non-conducted P waves

$\frac{2:1}{4:3}$ } Groups of three QRS complexes separated by 3 non-conducted P waves

$\frac{2:1}{5:4}$ } Groups of four QRS complexes separated by 3 non-conducted P waves

The number of QRS complexes in the Wenckebach sequence will be the denominator of the non-integral ratio in the lower level of a Type A multilevel AV block.

One can quickly determine the ratios for a **Type B** multilevel AV block with a non-integral block on the lower level. Count the P waves to the first non-conducted P wave (including the non-conducted P wave). That is the ratio of the Wenckebach episode on the lower level. For instance, if the sequence terminates on the 4th beat, then the ratio in the lower level will be 4:3. The lower level will be the ratio with the greatest degree of block and it will end first because it is automatically the shortest sequence. Next count on to the next non-conducted P wave. That marks the end of the Wenckebach sequence in the upper level. If it terminates on the 7th beat, then the sequence in the upper level is 7:6. It will be the longest Wenckebach sequence and the one with the lesser amount of block.

A non-conducted P wave that precedes a conducted P wave is considered to have been blocked in the upper level, which allows the following P wave to conduct unless the following P-R interval is prolonged, in which case the block occurred in the lower level. If there are two consecutive non-conducted P waves, the first is considered to have blocked in the lower level and the second in the upper level.

3:2
2:1

This will appear as a regular 3:1 block, without group beating, because in this particular case the two beats that fail to conduct are the ones that would have shown the P-R delay resulting in group beating.

With **Type B** multilevel AV blocks, we only concern ourselves with the upper level being “even” or “odd” when there is a 2:1 block in the lower level.

In Type B AV blocks with an EVEN numbered sequence in the upper level and 2:1 conduction in the lower level, there will be obvious alternation of P-R and R-R intervals. The P wave that blocks just before a conducted beat with a prolonged P-R interval is assumed to have blocked in the lower level (hence the residual relative refractoriness causing the prolonged P-R interval). The P wave that blocks just before a conducted beat with the shortest P-R interval is assumed to have blocked in the upper level (thus allowing recovery in both levels).

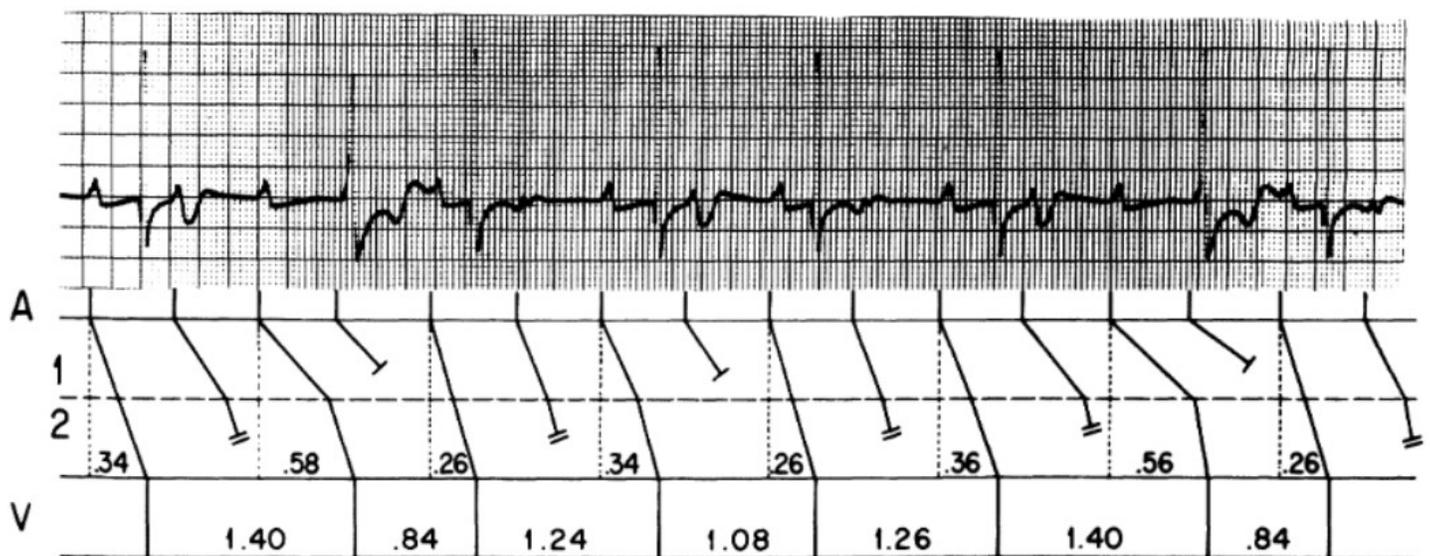
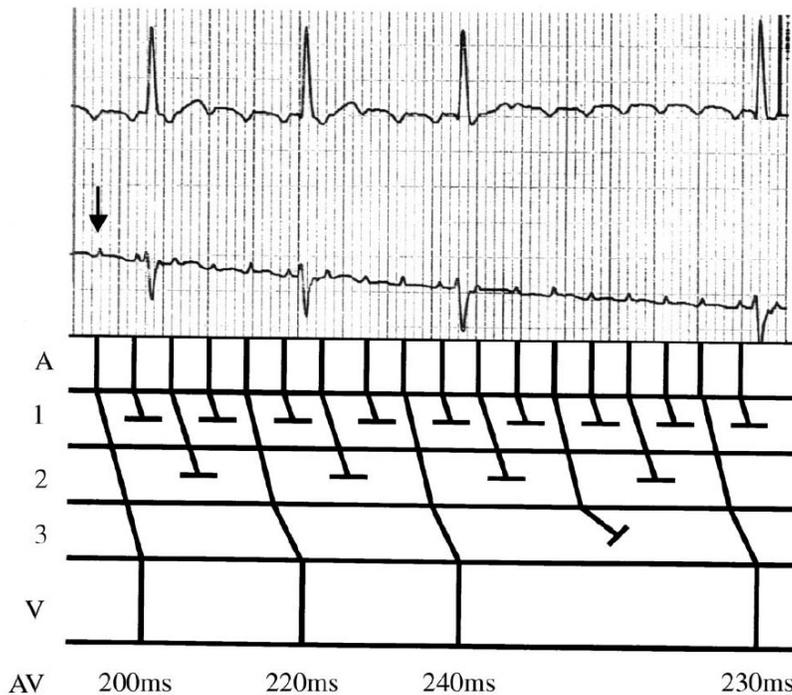


FIGURE 5. Type B pattern in patient 26. P-R and R-R intervals are noted in seconds. There is Wenckebach periodicity at the upper level and 2:1 block at the lower. Each cycle begins with a short P-R interval (0.26 sec) and terminates with a beat blocked at the upper level.

Note that when an impulse is blocked in the upper level, the following impulse conducts with a short P-R interval. This is because when an impulse is blocked in the upper level, the entire AV node/junction is able to recover and conduct more rapidly. When an impulse is blocked in the lower (or lowest) level, refractoriness persists, and conduction is slower. This results in a long P-R interval for the following conducted beat.

There are no pauses between Wenckebach sequences in a **Type B** multilevel AV block with an even number of beats in the Wenckebach sequence and a 2:1 block in the lower level because

the non-conducted P wave at the end of the Wenckebach sequence coincides with the non-conducted P wave of the 2:1 block in the lower level. Thus, since the block is initiated in the upper level, the entire AV node/junction is allowed to recover, and the following P-R interval is short. That also shortens the last R-R interval. So, the beginning of the 4:3 sequence is with the P-QRS that terminates the shortest R-R interval.



8:1 block requires three levels of block. It can be achieved (practically) one of two ways...

There must be three levels of block...

First, 2:1 / 2:1 / 2:1

Second, 2:1 / 2:1 / 4:3

Note that as we go from the 1st to the 2nd level, the 2:1 block gets “wider.” The beats do not coincide directly with the beats in the first level. Each beat of the 2:1 block in the 2nd level is separated by a P wave. If there were a 2:1 block in the 3rd level, each beat of the 2:1 block

would be separated by THREE P waves, creating an 8:1 block. An 8:1 block resulting from 2:1 blocks in all three levels would likely be somewhat persistent with 8:1 lasting for two or more episodes.

When 8:1 block results from a 4:3 block in the 3rd level, there cannot be two successive 8:1 episodes because the 8:1 block will only manifest when the Wenckebach sequence ends.

As a matter of fact, the 8:1 block really depends on the 2:1 blocks in the 1st and 2nd levels. The non-integral (Wenckebach) ratio simply determines how many episodes of 4:1 block there will be until the Wenckebach sequence ends and the 8:1 block appears. The 4:3 conduction ratio in the 3rd level produced two successive episodes of 4:1 block enclosed by the three conducted P waves followed by the 8:1 block when the final P wave of the Wenckebach sequence failed to conduct. A 5:4 Wenckebach sequence in the 3rd level would produce three episodes of 4:1 block bounded by the four conducted P waves followed by an 8:1 block when the 5:4 Wenckebach sequence ended. But note that no matter what the Wenckebach conduction ratio is, there cannot be two successive episodes of 8:1 block. That can only occur when all three levels manifest 2:1 conduction. If the Wenckebach ratio in the 3rd level were 3:2, then there would be alternating sequences of 4:1 and 8:1 conduction ratios.

If there were only two levels – **Type A** – with a 3:2 non-integral ratio in the lower level, there would be sequences of 2:1 and 4:1 block alternately.

With a **Type A** multilevel AV block, the presence of a non-integral ratio in the lower level (whether 2nd or 3rd level) will cause the block that has been achieved in the adjacent level to double. If the ratio is 3:2, this will occur every 2nd (i.e., every other) episode; if the ratio is 4:3, it will occur every third episode; 5:4, every 4th episode etc.

Whether a 2:1 block is present in the upper or lower level of a multilevel AV block that also contains a non-integral ratio, there will continue to be a P wave in between each of the conducted beats. Here's how you can distinguish between a **Type A** and a **Type B** multilevel AV block...

With **Type A**, there will be very obvious group beating and there will be a wide pause at the end of the Wenckebach episode. That pause will last for 3 atrial impulses.

With **Type B**, group beating may or may not be obvious. Sometimes the R-R intervals do not vary enough in duration to distinguish themselves as “group beating.” If the upper level has an even number of beats in the sequence, the blocked beat at the end of the Wenckebach cycle will coincide with the blocked beat of the 2:1 block in the lower level and terminate with just one blocked beat and a short R-R interval. If the upper level has an odd number of beats, the blocked beat at the end of the Wenckebach cycle will follow the blocked beat of the 2:1 block in the lower level and terminate with two blocked beats followed by a short P-R interval.