

Alternating Wenckebach periodicity: A common, yet overlooked, ECG phenomenon in high-frequency rhythms

Abstract

Electrocardiographic interpretation of high-rate atrial tachyarrhythmias can be challenging. We report a case of atrial tachycardia with a particular regularly irregular conduction pattern. Alternating Wenckebach periodicity is a common, yet overlooked, electrocardiographic phenomenon, frequent in high-frequency rhythms. Its recognition helps narrow the differential diagnosis, excludes atrial fibrillation, and guides appropriate management. Despite being described over a century ago, it remains a relevant and underrecognized finding in modern clinical practice.

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Case presentation

A 58-year-old man with a background history of hypertension and tobacco use presented to the Emergency Department (ED) for palpitations. He had previously undergone transcatheter pulmonary vein isolation for paroxysmal-persistent atrial fibrillation approximately 3 years ago. His medications included zofenopril 10 mg once daily, bisoprolol 2.5 mg once daily, edoxaban 60 mg once daily and flecainide 50 mg twice daily. Other episodes of palpitations had occurred frequently over the preceding 6 months. He accessed the ED a few days earlier, when a similar electrocardiogram had been misinterpreted as atrial fibrillation. On that occasion, anticoagulation was resumed based on a CHA₂DS₂-VA score of 2, and pharmacological cardioversion to sinus rhythm was successfully achieved with flecainide without complications. Laboratory testing revealed slight increase of myocardial necrosis markers (hs-TnT of 32 pg/mL), normal hemoglobin levels (16 g/dL) and white blood cell count (7800/ μ L), slightly impaired kidney function (glomerular filtration rate of 55 ml/min per 1.73 m² with urea nitrogen levels at 39 mg/dL and creatinine levels at 1.24 mg/dL), no electrolytes abnormalities.

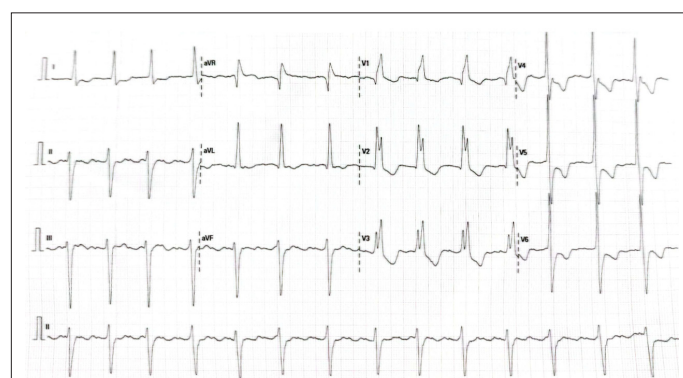


Figure 1: Twelve-lead electrocardiogram on admission showing a slightly irregular wide QRS-complex tachycardia (≈ 100 bpm) with right bundle branch block and left anterior fascicular block. Careful analysis reveals alternating Wenckebach periodicity with alternating pattern of 2:1/3:1 atrioventricular conduction.

Interpretation

What is the atrial rhythm?

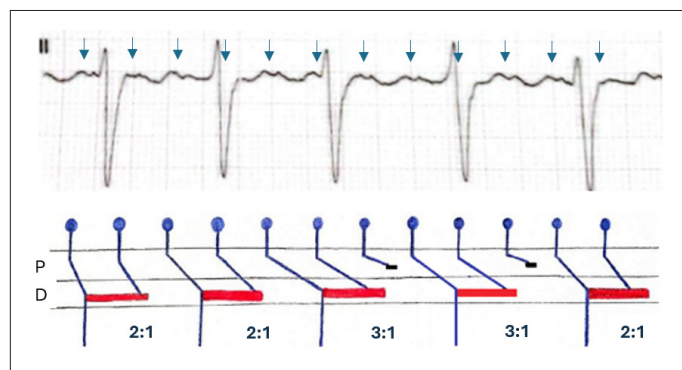
The electrocardiogram shows a slightly irregular wide QRS-complex tachycardia (QRS duration approximately 150 msec) at 100 bpm, consistent with a supraventricular tachycardia with aberrant conduction due to right bundle branch block and left anterior fascicular block. Increased voltages in both left and right precordial leads suggest biventricular hypertrophy. Careful inspection reveals clearly identifiable wide P waves. The atrial cycle length is approximately 280 msec, corresponding to an atrial rate of about 210 bpm, consistent with atrial tachycardia. The P waves are wide and bifid, positive in the inferior leads and isoelectric in lead I and V1, suggesting a left-sided superior site of origin (left superior pulmonary vein/left atrial appendage [1]). The P-wave duration of approximately 150 ms suggests left atrial enlargement and partial interatrial block (IAB), consistent with delayed conduction between the right and left atria via Bachmann Bundle (BB). P-wave and QRS morphologies are suggestive of left ventricular hypertrophy and left atrial enlargement, observed on echocardiography. Atrial impulses are not conducted regularly, but follow a regularly irregular pattern, with alternating 2:1 and 3:1 atrioventricular conduction, determining alternating Wenckebach periods.

Discussion

Alternating Wenckebach periodicity is a tachycardia-dependent electrophysiological phenomenon, observed during atrial tachycardia, atrial flutter or atrial pacing with 2:1 conduction block, characterized by a gradual prolongation of the conduction intervals, preceding the appearance of 3:1 or 4:1 block. This phenomenon is associated with transverse or horizontal dissociation within more segments of the atrioventricular conduction system, resulting in multilevel block [2]. Non-conducted atrial impulses partially penetrate the atrioventricular junctional tissues, according to concealed conduction phenomenon [3]. Although alternating Wenckebach occurs most commonly within the atrioventricular node, it may also involve structures outside it [4]. For example, in patients with right bundle branch block, it may result from involvement of the His bundle only, the left bundle branch only or both structures simultaneously. Events observed during two-level block follow a mathematical pattern: progression of 2:1 to 3:1 block can result from the coexistence of Wenckebach period at the proximal level with a 2:1 block at the distal level, while alternation between 2:1 and 4:1 block can occur with a 2:1 block at the proximal level and a Wenckebach phenomenon at the distal level. In our case, a 2:1 block at the distal level coexists with a proximal Wenckebach-type block, resulting in alternating 3:1 and 2:1 block.

Conclusion

In conclusion the correct report of the ECG is: atrial tachycardia with 2:1 conduction, alternating with Wenckebach 3:1 periodicity, intra-atrial block/left atrial enlargement, anterior fascicular block, right bundle branch block, biventricular hypertrophy, secondary repolarization abnormalities.



Conclusion

Careful evaluation of each finding allowed for appropriate clinical interpretation of the case. The patient, with hypertrophic cardiomyopathy and prior pulmonary vein isolation, developed focal micro-reentry circuit atrial tachycardia, involving left superior pulmonary vein, as demonstrated by an electrophysiological study. The detection of alternate Wenckebach pattern, typical in high atrial frequencies, allows exclusion of an atrial fibrillation or sinus tachycardia, narrowing the differential diagnosis to atrial flutter or atrial tachycardia, as shown in our case. Understanding the rhythm is essential to correct management, because atrial tachycardia does not require anticoagulation therapy and responds poorly to antiarrhythmics, compared to ablation therapy.

Take-home points

- Alternating Wenckebach periodicity is a common phenomenon during high atrial frequency tachycardias, such as atrial flutter and atrial tachycardia, and reflects the occurrence of a multilevel atrioventricular conduction block.
- A regularly irregular pattern, with alternating 2:1 and 3:1/4:1 atrioventricular conduction, should suggest an alternating Wenckebach periodicity.
- Recognition of this electrocardiographic pattern allows accurate identification of the underlying rhythm, avoids misdiagnosis (e.g., atrial fibrillation) and guides appropriate management.

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