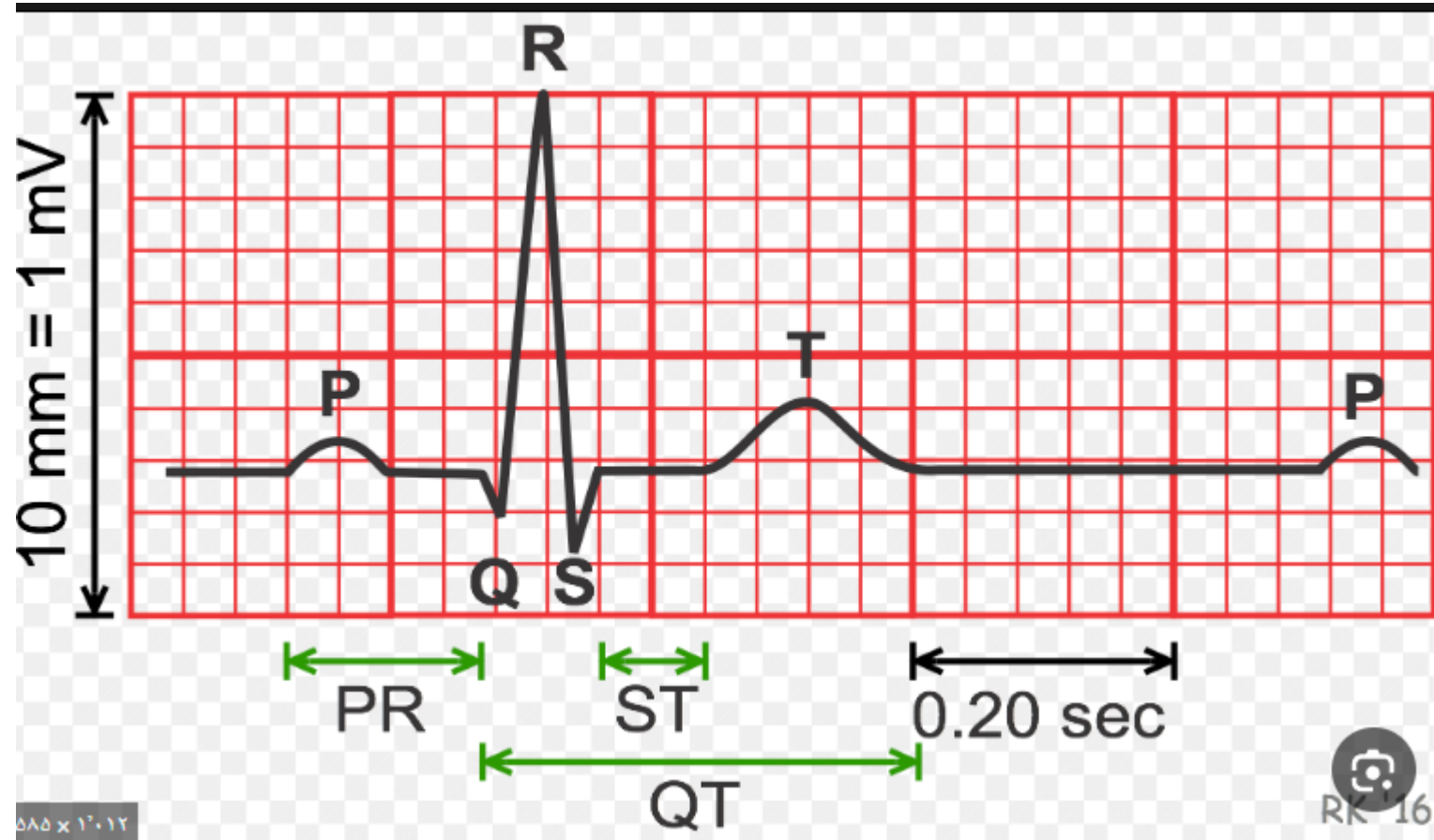
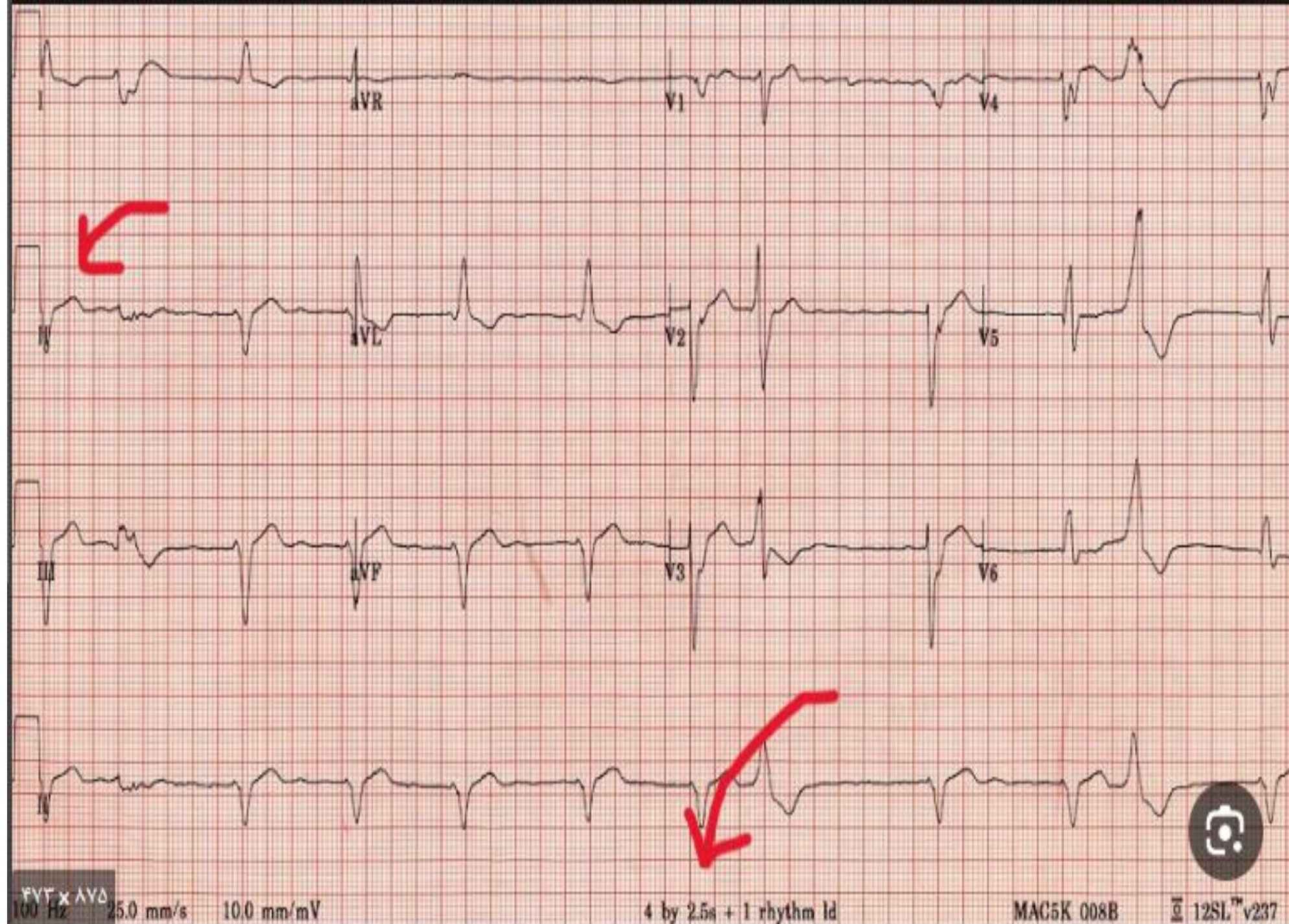




بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ







FVT x AVA
100 Hz

25.0 mm/s

10.0 mm/mV

4 by 2.5s + 1 rhythm Id

MAC5K 008B

12SL™ v237

Question:

26-year-old man prior to enrolling in anti-convulsive medication trial. What is your summary interpretation (choose ONE)? *

Difficulty rating

- a) Left ventricular hypertrophy
- b) Brugada pattern
- c) Right axis deviation
- d) Sinus rhythm; within normal limits**
- e) Incomplete left bundle branch block

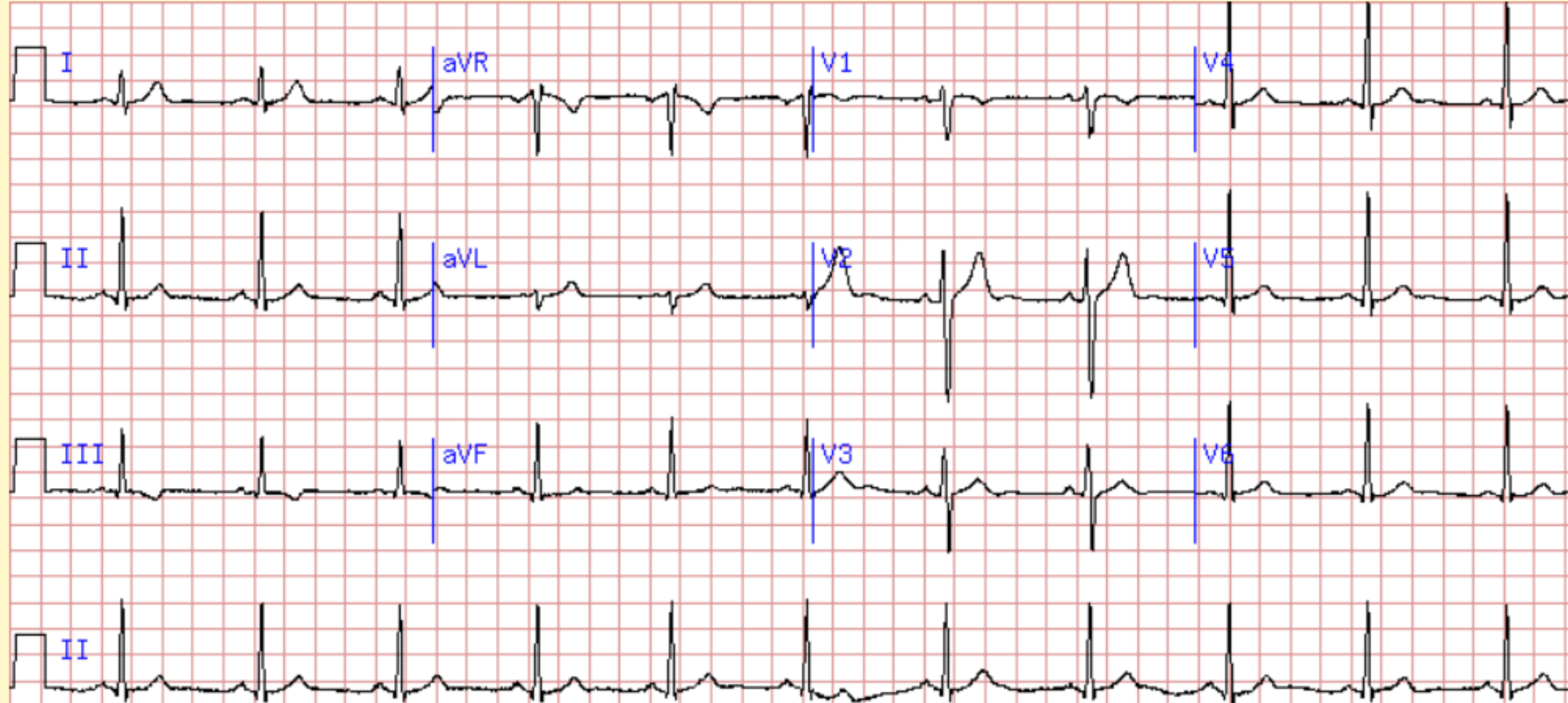
Answer:

The ECG is within normal limits. Sinus rhythm is present at a rate of about 66/min with normal QRS axis (about +75 degrees) and intervals. Precordial (chest lead) voltage may appear somewhat prominent but is well within normal range, especially in young adults, without left atrial abnormality or ST-T changes of left ventricular hypertrophy.

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Question:

78 year-old man with a history of "heart attack" comes into the emergency department with complaints of palpitations and shortness of breath. What is the wide-complex rhythm? Note: serum K⁺ was normal and he was not on any antiarrhythmic drugs. *** *Difficulty rating*

- a) Atrial tachycardia with Wolff-Parkinson-White pre-excitation
- b) Atrial tachycardia with right bundle branch block aberration
- c) Monomorphic ventricular tachycardia
- d) Atrial flutter with right bundle branch block aberration
- e) Sinus tachycardia with left bundle branch block aberration

Your Answer:

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- a) Atrial tachycardia with Wolff-Parkinson-White pre-excitation
- b) Atrial tachycardia with right bundle branch block aberration
- c) **Monomorphic ventricular tachycardia**
- d) Atrial flutter with right bundle branch block aberration
- e) Sinus tachycardia with left bundle branch block aberration

This ECG shows a very wide-complex (between 180-200 msec) tachycardia at a rate about 180 bpm with a right bundle branch (RBBB) morphology. The diagnosis of monomorphic ventricular tachycardia with a RBBB morphology is strongly supported by the following criteria: 1) Wide QRS (greater than 140 ms) in the absence of drugs or hyperkalemia (the QRS here is extremely wide); 2) wide monophasic R wave in lead V1 (or RS or QR complex in that lead); 3) QR complexes in the inferior leads with extreme axis deviation; 4) rS or QS waves in V6.

A resting rate of 180 bpm excludes sinus tachycardia, especially in this age group. There is no evidence of atrial flutter or atrial tachycardia, and, as described, the QRS morphology here is strongly against aberrant supraventricular conduction.

Answer:

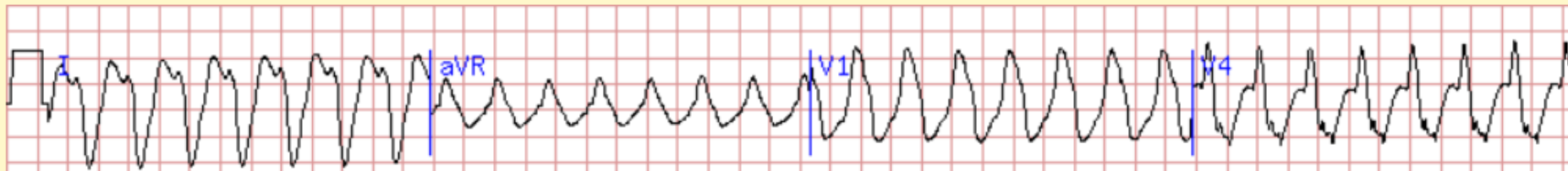
This patient had a complicated cardiac history of coronary artery disease, status post bypass graft surgery and prior inferior infarction. He had recurrent ventricular tachycardia, likely originating the area of the prior inferior infarct. An echocardiogram revealed showed a dilated left atrium and left ventricle, extensive thinning with an akinetic scar of the inferior base and moderately severe mitral regurgitation. Estimated left ventricular ejection fraction was 35%. Under conscious sedation the patient was converted to sinus rhythm with a 300-joule shock. An automatic implantable cardioverter-defibrillator (ICD) was placed the following day.

Compare this ECG with Case #270 showing monomorphic ventricular tachycardia with a left bundle branch block morphology and underlying myocardial infarction. Also, note that the QRS duration in lead II may appear to be normal, with the false appearance of a P wave at the end. However, if you draw lines down from the onset and end of the QRS in simultaneously acquired lead I, you will see that the QRS in lead II is actually close to 200 msec wide and that the terminal deflection is not a P wave, but part of the QRS.

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Question: Wide complex tachycardia in a 77-year-old man with coronary artery disease. What is the rhythm? * * * * *Difficulty rating*

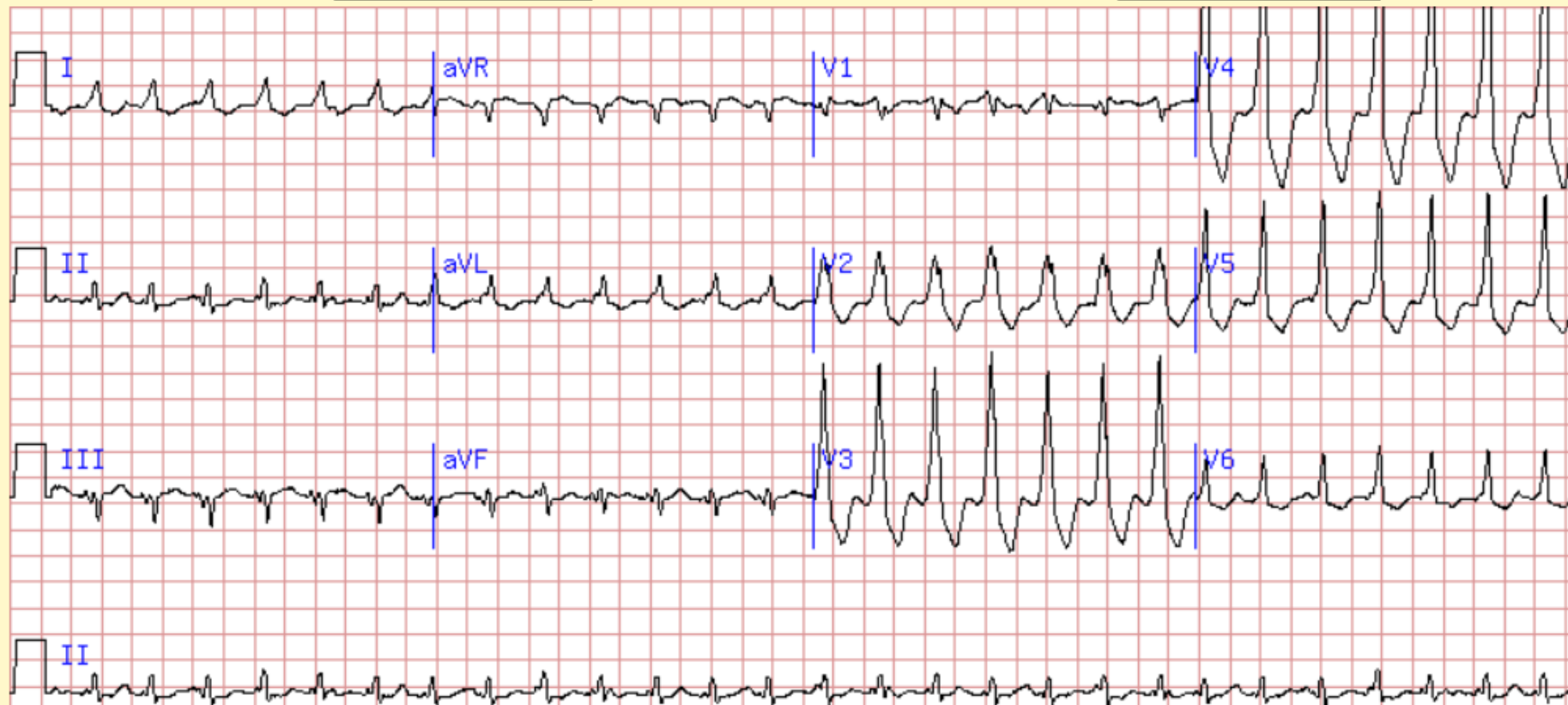
- a) Wolff-Parkinson-White pre-excitation with antidromic conduction during atrio-ventricular reentrant tachycardia (AVRT)
- b) Sinus tachycardia with right bundle branch block aberrancy
- c) Ventricular tachycardia with underlying sinus tachycardia and AV dissociation
- d) AV nodal reentrant tachycardia with right bundle branch block aberrancy
- e) Atrial flutter with 2:1 AV conduction and right bundle branch block aberrancy

Your Answer:

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Question: Wide complex tachycardia in a 77-year-old man with coronary artery disease. What is the rhythm? * * * * *Difficulty rating*

- a) Wolff-Parkinson-White pre-excitation with antidromic conduction during atrio-ventricular reentrant tachycardia (AVRT)
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- d) AV nodal reentrant tachycardia with right bundle branch block aberrancy
- e) Atrial flutter with 2:1 AV conduction and right bundle branch block aberrancy

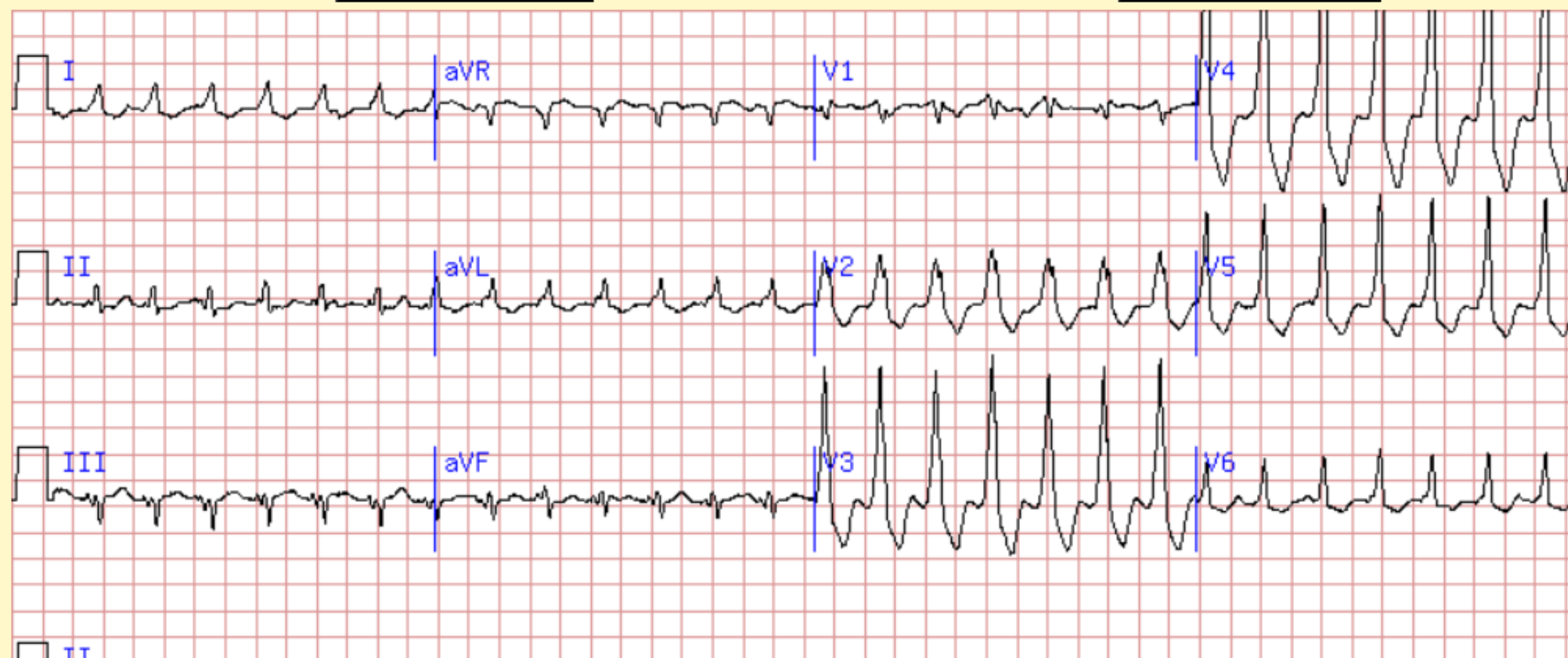
Answer:

c) There is a wide complex tachycardia at about 165/min with an right bundle branch block (RBBB) morphology. Underlying sinus tachycardia at about 136/min and AV dissociation are noted, confirming the diagnosis of ventricular tachycardia (VT). (Note the clear sinus P waves, e.g., just after 5th QRS.) The QRS morphology and axis are consistent with origin of the VT from the posterior septum. The patient had had a prior large inferior-posterior myocardial infarction (MI). (Of additional note here is the relatively low limb lead voltage and sinus tachycardia). There was a small-moderate pericardial effusion remaining after recent pericardiocentesis for tamponade.

[Hide Answer](#)

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Question:

Elderly man with history of coronary disease and chronic atrial fibrillation presents with palpitations and hypotension. What is the mechanism of this wide-complex tachycardia? * * * *Difficulty rating*

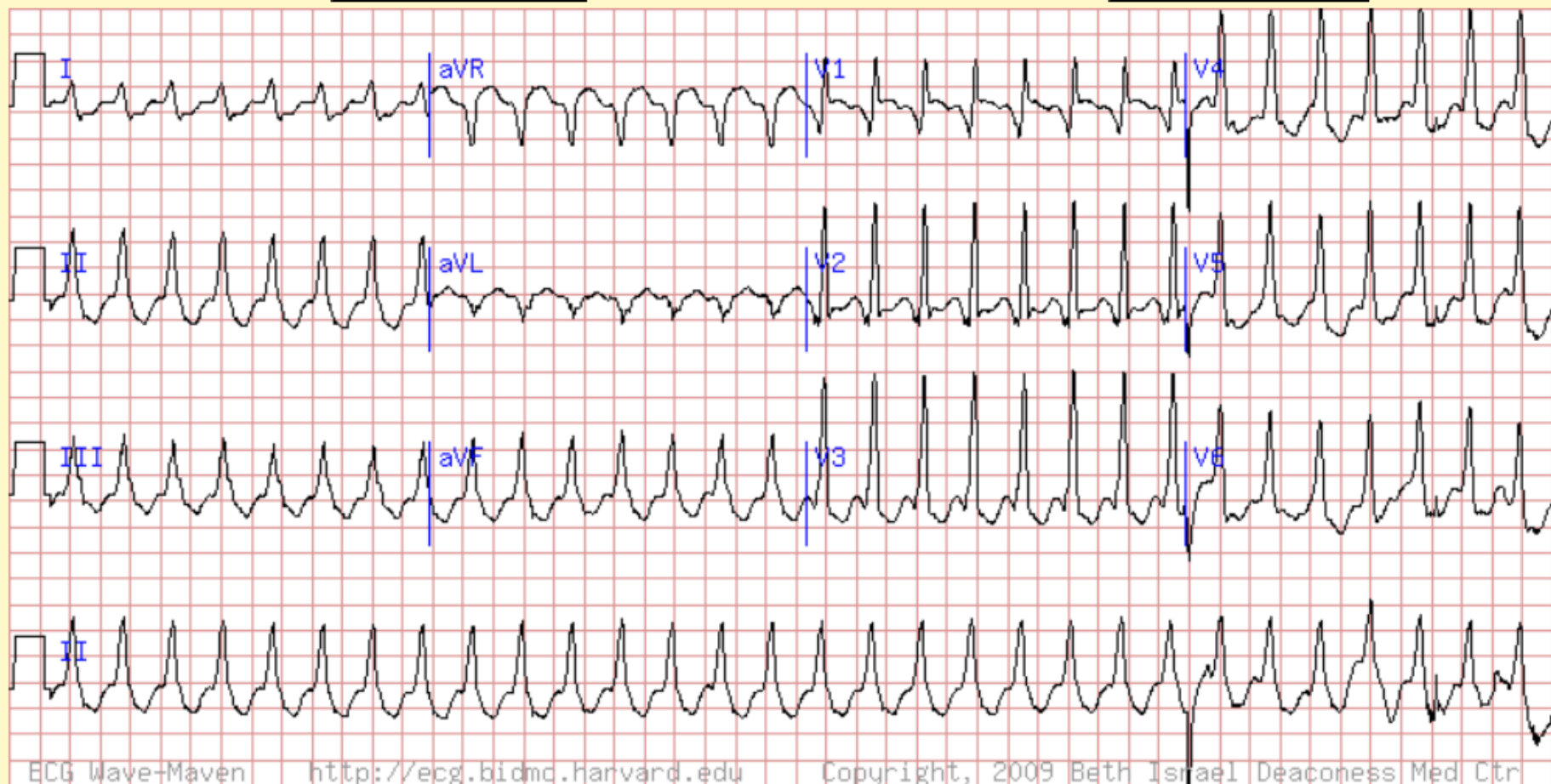
- a) Atrial flutter with right bundle branch block (RBBB)
- b) Monomorphic ventricular tachycardia
- c) Sinus tachycardia with RBBB
- d) Atrial tachycardia with left bundle branch block
- e) AV nodal reentrant tachycardia (AVNRT) with RBBB

Your Answer:

Show Answer

High Resolution Image

PDF (zoomable) Image



Question:

Elderly man with history of coronary disease and chronic atrial fibrillation presents with palpitations and hypotension. What is the mechanism of this wide-complex tachycardia? * * * *Difficulty rating*

- a) Atrial flutter with right bundle branch block (RBBB)
- b) Monomorphic ventricular tachycardia**
- c) Sinus tachycardia with RBBB
- d) Atrial tachycardia with left bundle branch block
- e) AV nodal reentrant tachycardia (AVNRT) with RBBB

This ECG shows a regular wide-complex (QRS duration 0.13 sec) tachycardia (rate of about 180/min). The QRS has a right bundle branch block (RBBB) morphology with a normal axis and QR complexes in V1-V3 consistent with monomorphic VT in the setting of underlying anterior MI. Under conscious sedation, the patient was cardioverted to his baseline atrial fibrillation with pathologic Q waves V1-V4, RBBB and a leftward axis with a QRS duration of 0.15 sec. (note: longer than that during VT).

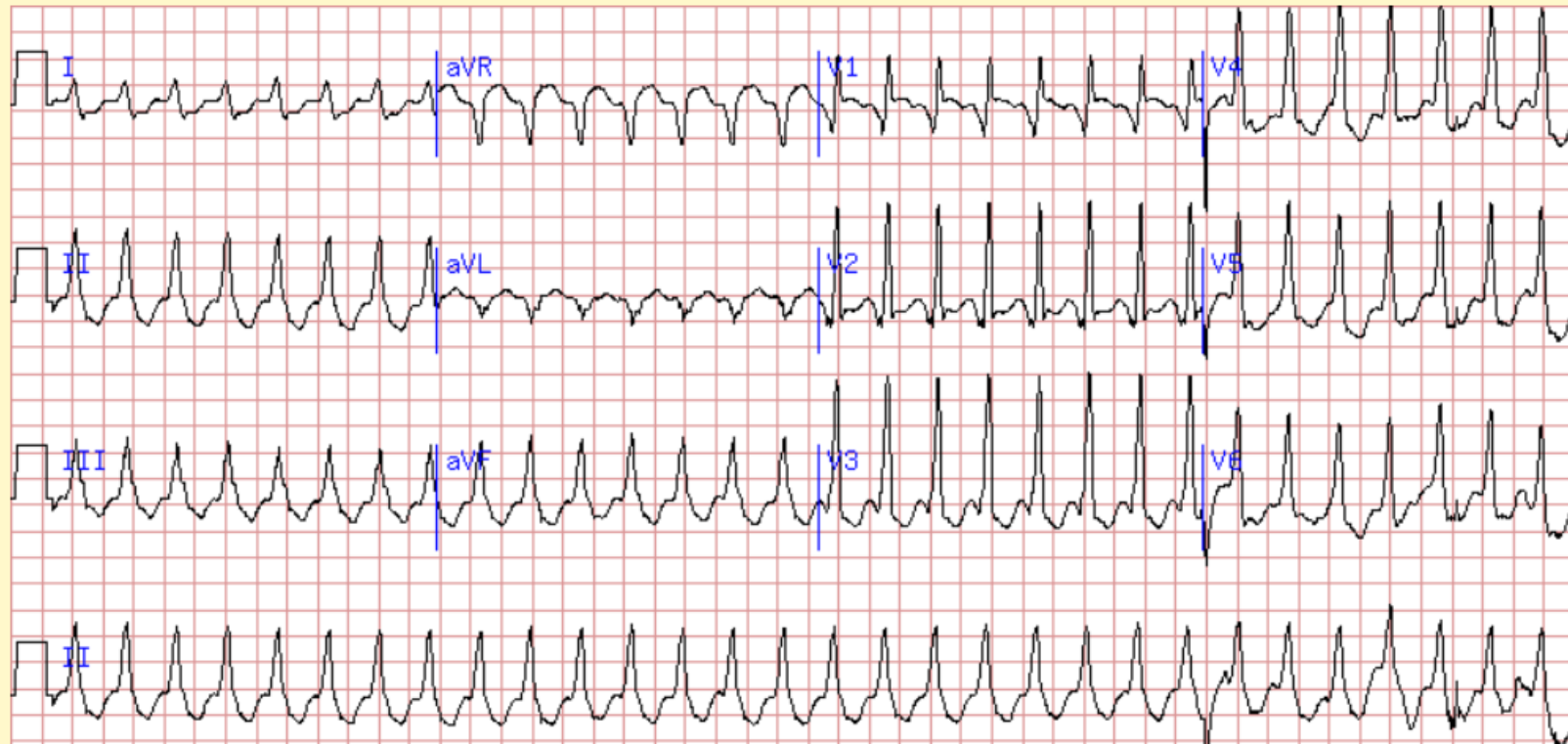
Answer:

Cardiac EP testing revealed easily inducible VT of several morphologies, including that on the present ECG. He underwent ICD placement. He had documented prior anterior infarction, with a markedly reduced left ventricular ejection fraction of 25-30%.

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Question:

This ECG from a 62 year old woman with a history of atrial fibrillation is most consistent with which ONE of the following rhythms? * * * *Difficulty rating*

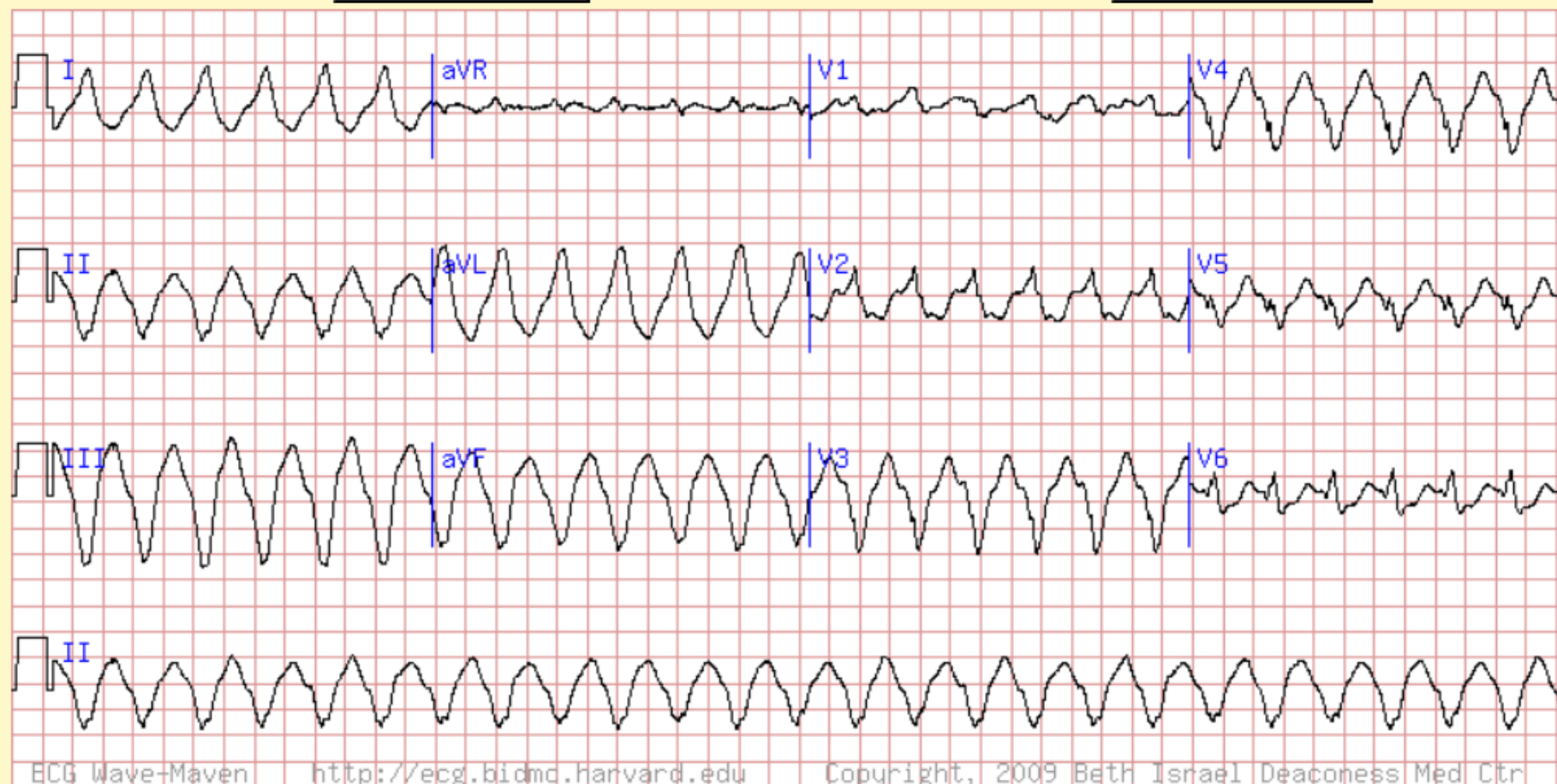
- a) Sinus tachycardia with right bundle branch block
- b) Monomorphic ventricular tachycardia
- c) Hyperkalemia sine-wave pattern
- d) Torsade(s) de pointes
- e) Atrial fibrillation with aberrancy

Your Answer:

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Question: This ECG from a 62 year old woman with a history of atrial fibrillation is most consistent with which ONE of the following rhythms? *** *Difficulty rating*

- a) Sinus tachycardia with right bundle branch block
- b) Monomorphic ventricular tachycardia**
- c) Hyperkalemia sine-wave pattern
- d) Torsade(s) de pointes
- e) Atrial fibrillation with aberrancy

The ECG shows a regular wide complex tachycardia at about 150/min. In strong favor of ventricular tachycardia are two major findings: the broad RS waves in V1 and V2 with an atypical RBBB morphology and the very wide QRS duration (180 msec). No atrial activity is apparent. The patient had a history of mitral valve replacement and prior inferior-lateral MI with left ventricular (LV) dilation and a reduced LV ejection fraction of 35-40%.

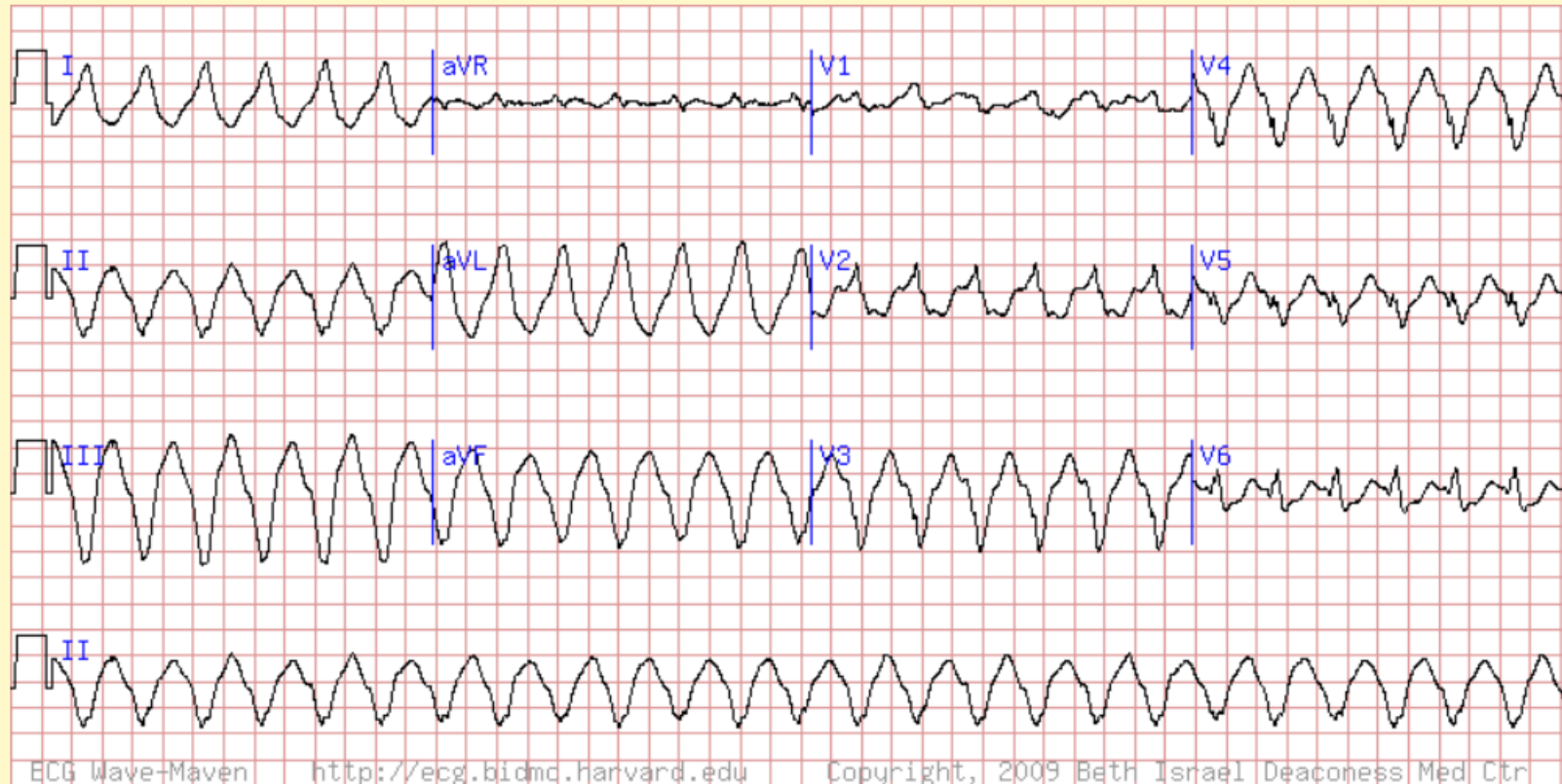
Answer:

This rhythm required DC cardioversion and the patient underwent successful radiofrequency catheter ablation of VT sites in the LV at the inferior wall to mitral valve regions.

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Question: ECG from a 74 year old woman shows which ONE of the following rhythm disturbances? * * * *Difficulty rating*

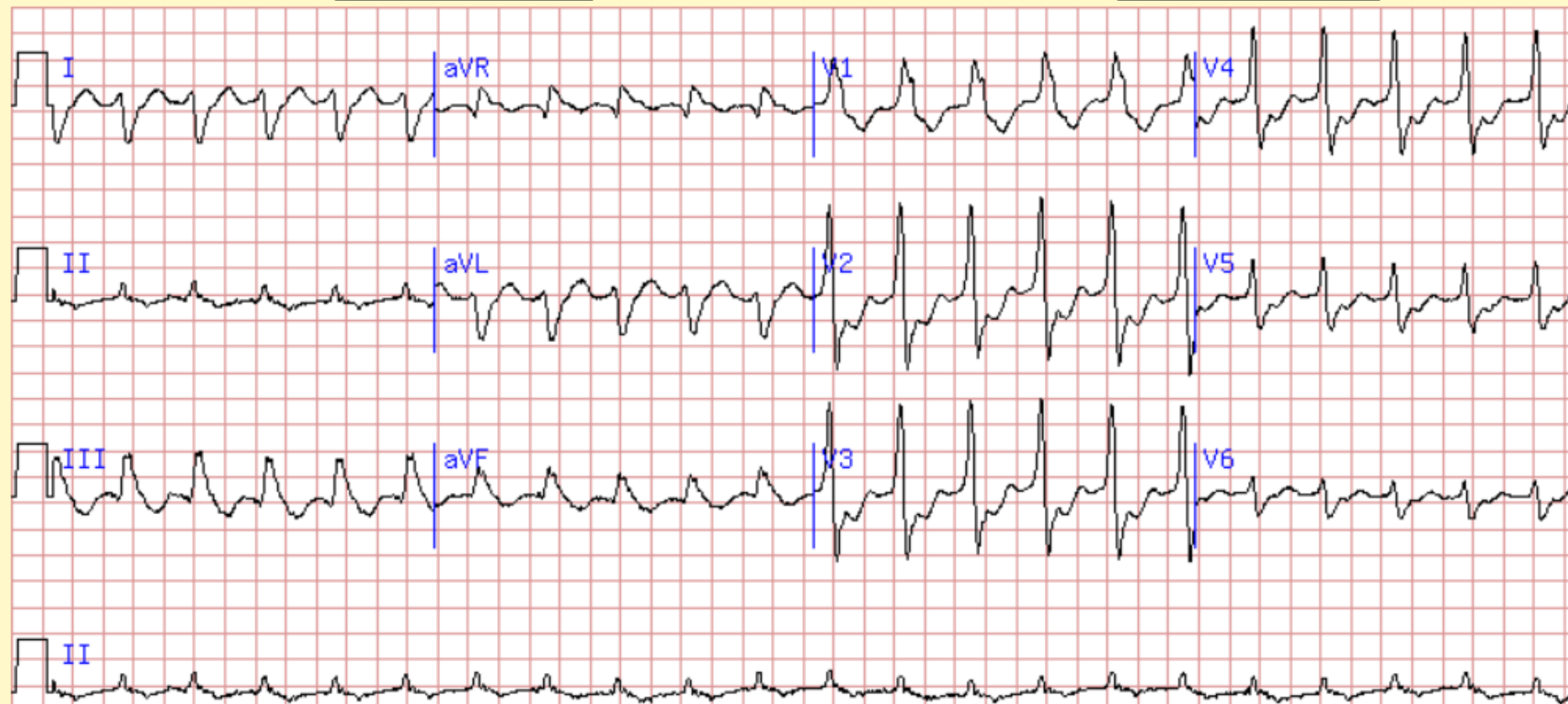
- a) Atrial tachycardia with right bundle branch block (RBBB) aberrancy
- b) Sinus tachycardia with RBBB aberrancy
- c) Ventricular tachycardia (VT), monomorphic
- d) AV nodal reentrant tachycardia (AVNRT) with RBBB aberrancy
- e) Atrioventricular reentrant tachycardia (AVRT) with antidromic conduction via a posterior bypass tract

Your Answer:

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Question:

ECG from a 74 year old woman shows which ONE of the following rhythm disturbances? * * * *Difficulty rating*

- a) Atrial tachycardia with right bundle branch block (RBBB) aberrancy
- b) Sinus tachycardia with RBBB aberrancy
- c) Ventricular tachycardia (VT), monomorphic**
- d) AV nodal reentrant tachycardia (AVNRT) with RBBB aberrancy
- e) Atrioventricular reentrant tachycardia (AVRT) with antidromic conduction via a posterior bypass tract

The ECG shows a regular, wide-complex tachycardia (WCT) at 130/min with an RBBB morphology (V1). Definite P waves are not seen. With an RBBB morphology, the diagnosis of VT is very strongly favored by the presence of multiple findings seen here including: a monophasic wide R wave in V1 (or an Rsr~ or qR-type morphology), a very wide QRS (>140-160 ms here, especially without hyperkalemia or sodium channel blocking drug effect), and an rS or QS in V6. Marked right axis deviation is also present here.

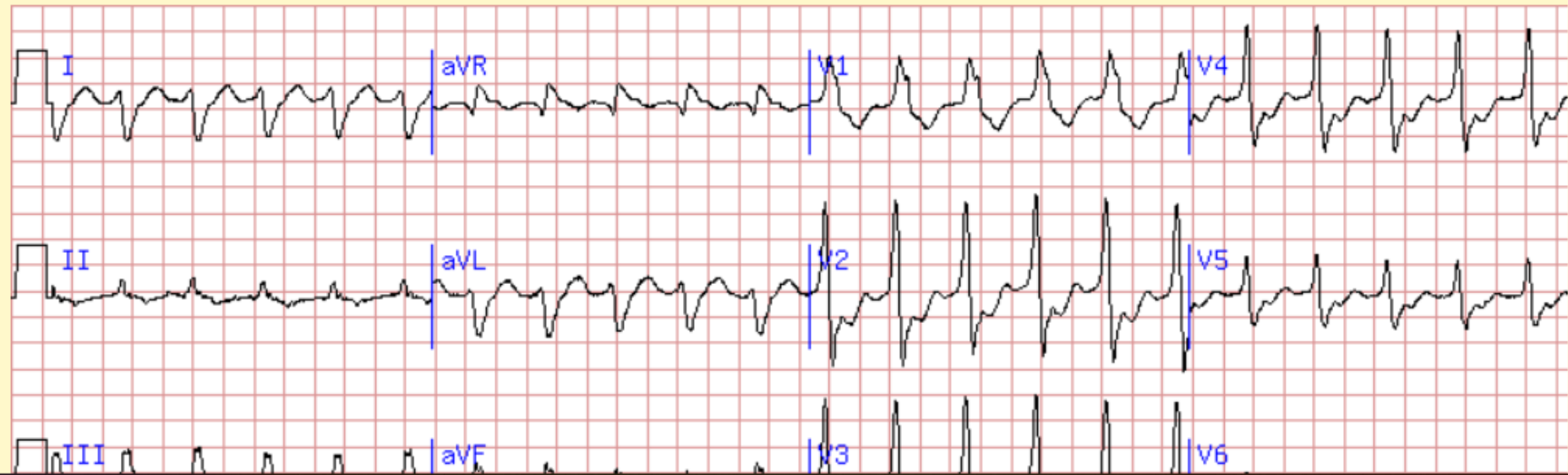
Answer:

~~~~~The patient had severe coronary disease with an underlying posterior-inferior wall aneurysm, the likely general origination site of the tachyarrhythmia. This type of monomorphic VT is usually originates in the vicinity of an underlying ventricular scar. The absence of evident AV dissociation (including independent sinus P waves, and/or capture or fusion beats) is non-diagnostic, as is the absence of positive or negative QRS concordance. The ST depressions (V1-V4) are not diagnostic in the context of the VT, but acute ischemia or even infarction, e.g., as a consequence of the tachycardia, is not excluded.

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**Question:** ECG from an elderly man. What is the rapid rhythm disturbance? \*\* *Difficulty rating*

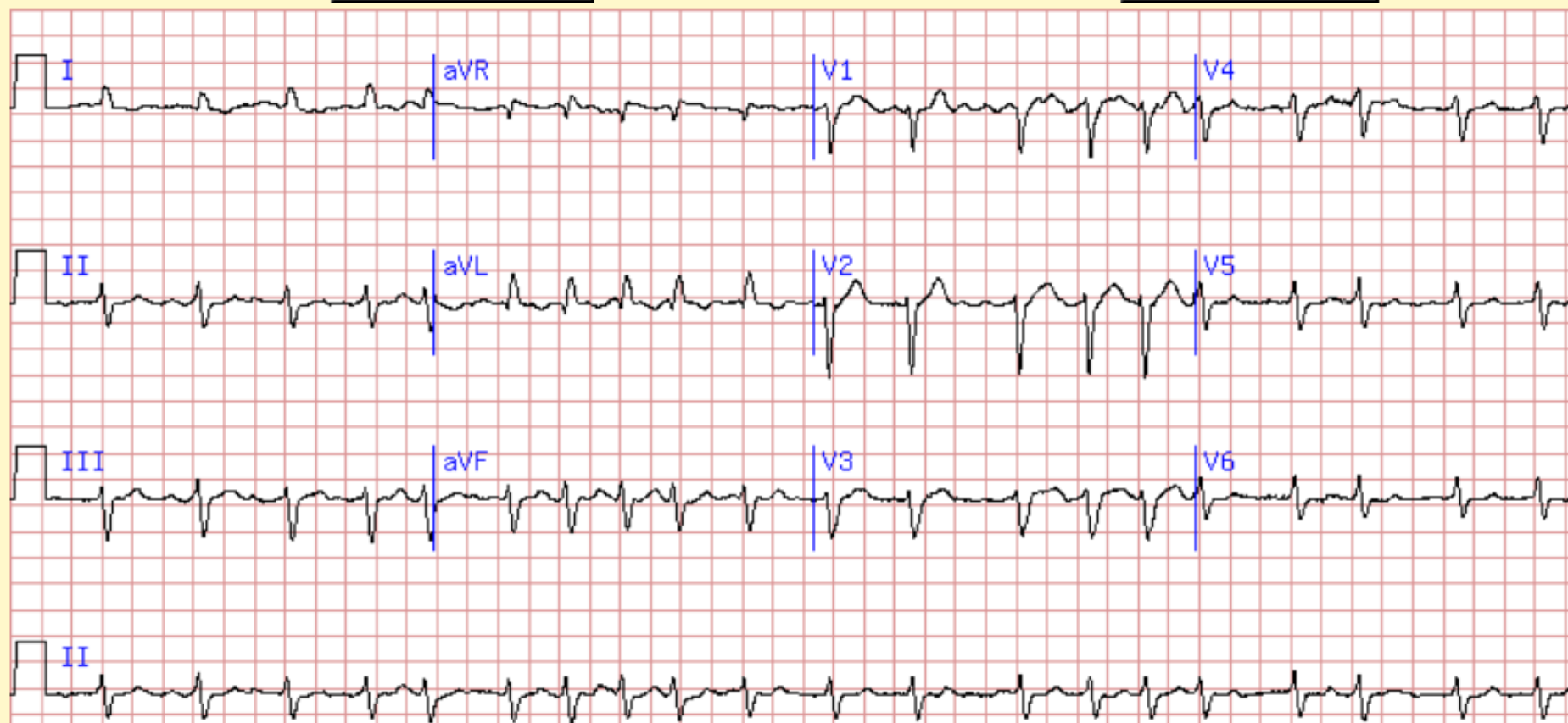
- a) Atrial fibrillation
- b) Atrial flutter with variable block
- c) Multifocal atrial tachycardia (MAT)
- d) AV nodal reentrant tachycardia (AVNRT)
- e) Polymorphic ventricular tachycardia (VT)

**Your Answer:**

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**Question:** ECG from an elderly man. What is the rapid rhythm disturbance? \*\* *Difficulty rating*

- a) **Atrial fibrillation**
- b) Atrial flutter with variable block
- c) Multifocal atrial tachycardia (MAT)
- d) AV nodal reentrant tachycardia (AVNRT)
- e) Polymorphic ventricular tachycardia (VT)

The ECG shows atrial fibrillation (AF) with a very rapid ventricular response. The average resting heart rate (over 10 sec of data) is 120/min, with instantaneous heart rates ranging from about 80-170/min. There is an intraventricular conduction delay (QRS duration about 130 ms). Left axis deviation is present, consistent with left anterior fascicular block. Slow R wave progression and non-specific ST-T changes are present. Lead aVL shows a prominent but non-diagnostic Q wave.

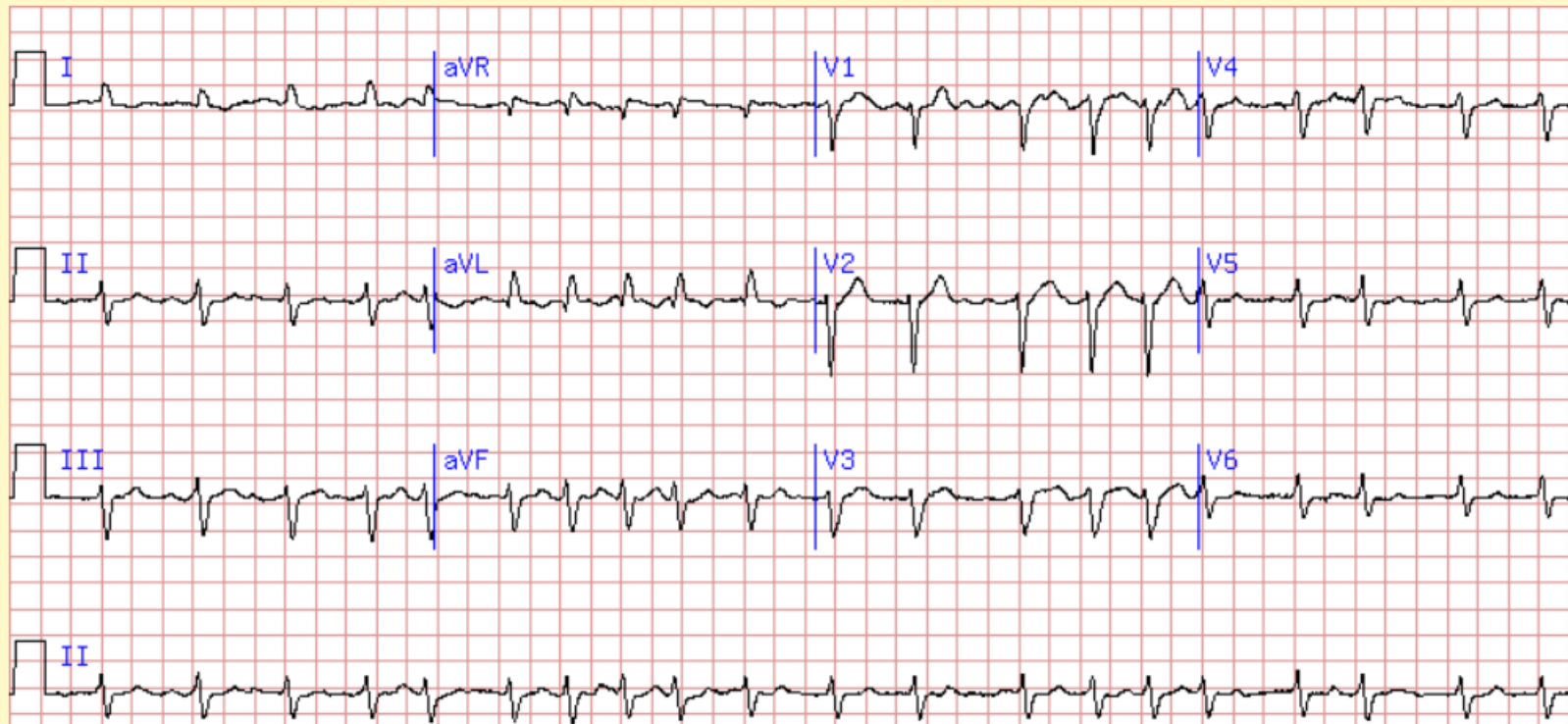
**Answer:**

The patient had severe ischemic cardiomyopathy, with prior extensive anterior wall infarction. The constellation of ECG abnormalities is consistent with that diagnosis.

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**Question:** This ECG from a middle-aged man shows which ONE of the following arrhythmias? \*\* *Difficulty rating*

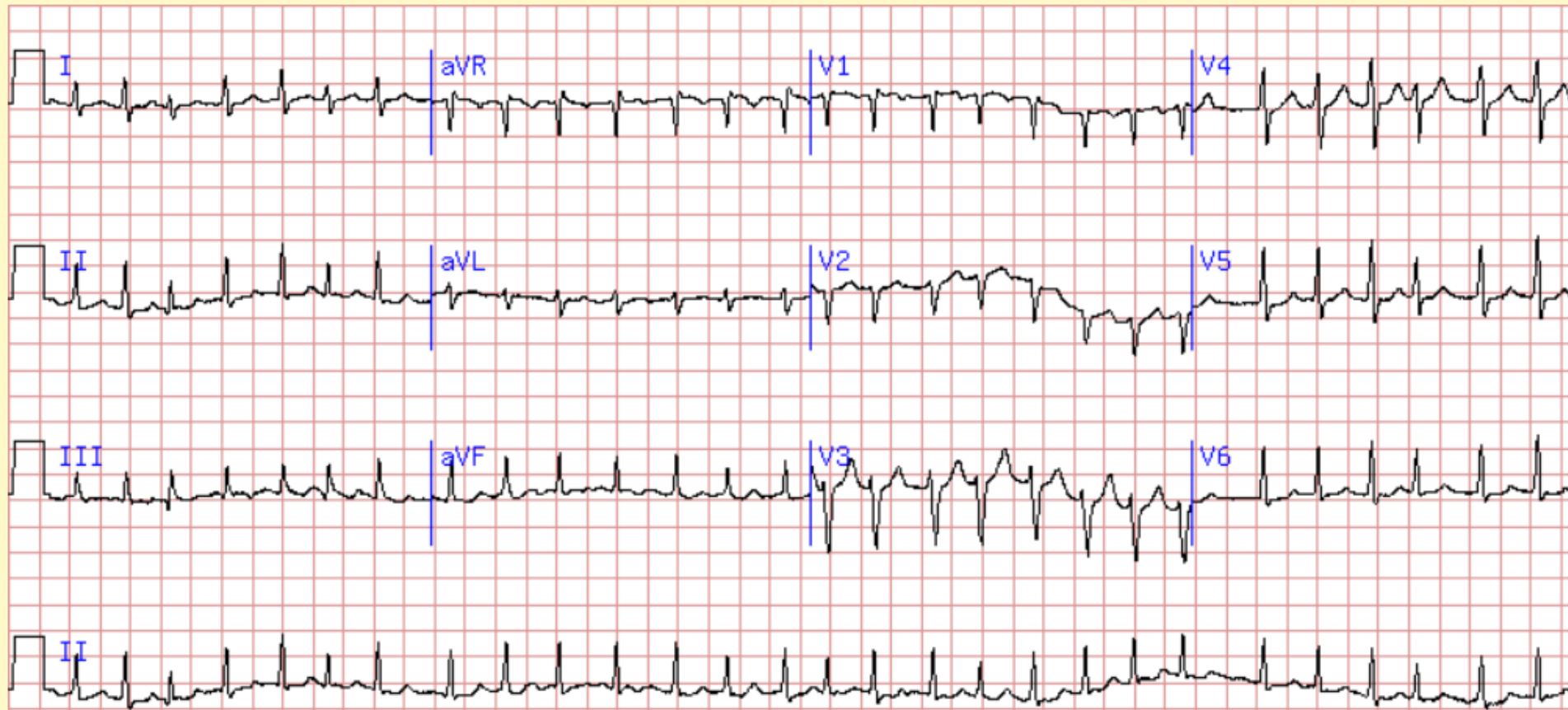
- a) Sinus tachycardia with frequent atrial premature beats
- b) Atrial flutter with variable block
- c) AV nodal reentrant tachycardia (AVNRT)
- d) Atrial fibrillation (AF)
- e) Multifocal atrial tachycardia (MAT)

**Your Answer:**

Show Answer

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**Question:** This ECG from a middle-aged man shows which ONE of the following arrhythmias? \*\* *Difficulty rating*

- a) Sinus tachycardia with frequent atrial premature beats
- b) Atrial flutter with variable block
- c) AV nodal reentrant tachycardia (AVNRT)
- d) Atrial fibrillation (AF)**
- e) Multifocal atrial tachycardia (MAT)

The ECG shows atrial fibrillation (AF) with a very rapid ventricular response (about 168/min at rest here). Artifactual drift of the baseline is present. There are nonspecific ST-T changes and relatively slow R wave progression, also a non-diagnostic finding.

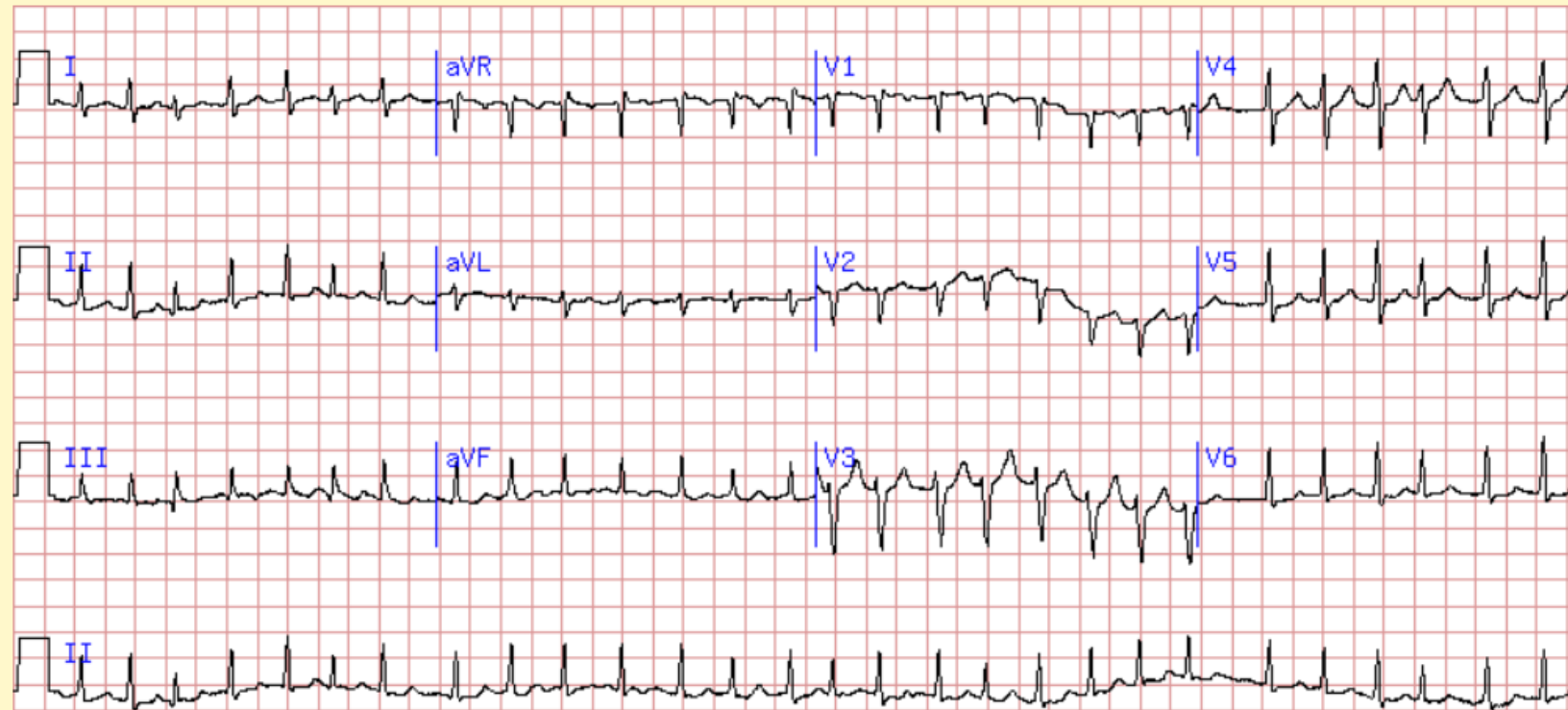
**Answer:**

The patient had a history of systemic hypertension. Echocardiogram showed mild concentric left ventricular hypertrophy (not evident on this ECG) and normal overall ventricular and valvular function.

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**Question:** What is this arrhythmia? \* \* *Difficulty rating*

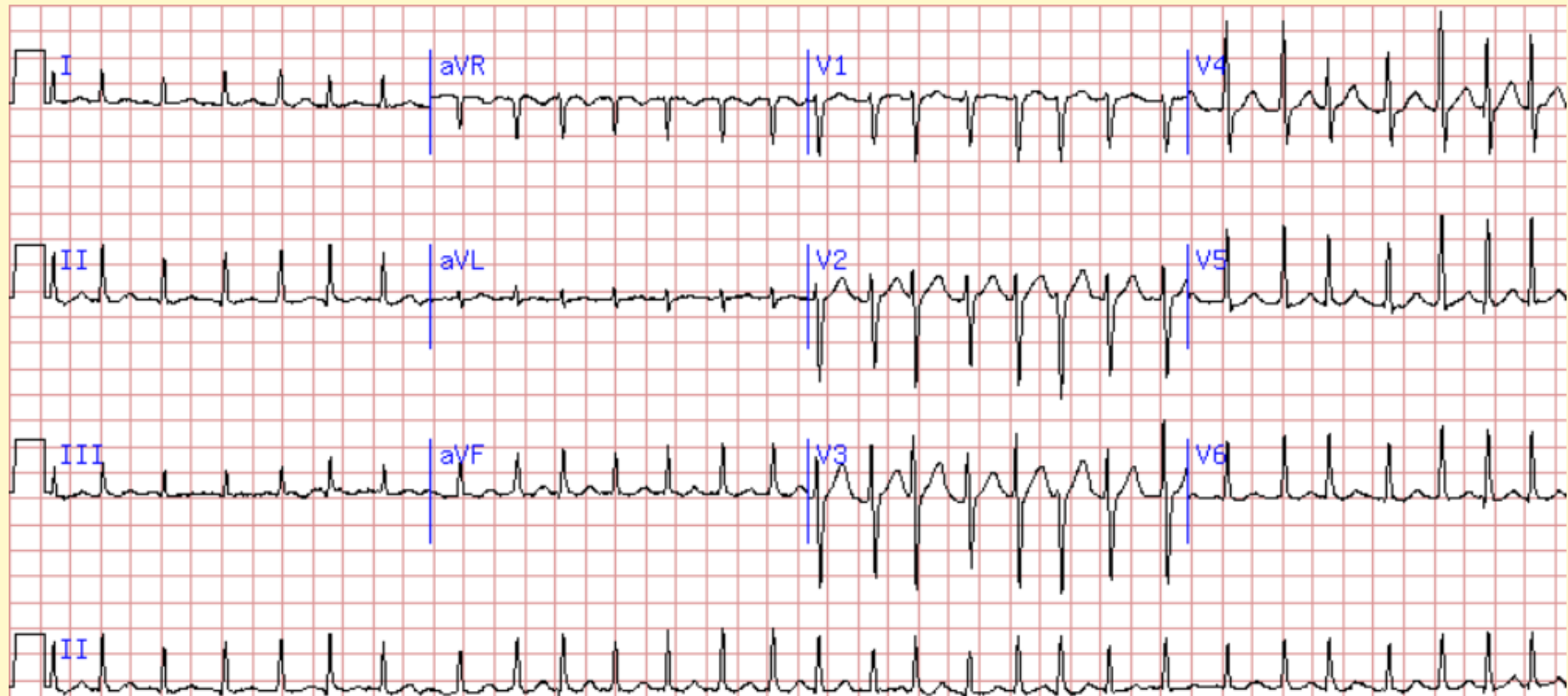
- a) Sinus tachycardia with premature atrial complexes
- b) Multifocal atrial tachycardia
- c) Atrial fibrillation
- d) Atrial flutter with variable block
- e) AV nodal reentrant tachycardia

**Your Answer:**

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**Question:** What is this arrhythmia? \* \* *Difficulty rating*

- a) Sinus tachycardia with premature atrial complexes
- b) Multifocal atrial tachycardia
- c) Atrial fibrillation**
- d) Atrial flutter with variable block
- e) AV nodal reentrant tachycardia

c) This is a classic example of atrial fibrillation (AF) with a very rapid ventricular response (average about 170/min). The baseline shows the characteristic wiggly fibrillatory activity (not discrete P waves) and the ventricular response is highly irregular ("irregularly irregular"). The absence of clearly defined P waves excludes sinus rhythm with premature atrial complexes (PACs) or multifocal atrial tachycardia (MAT.) There are also no consistent flutter ("saw-tooth") waves and this degree of beat-to-beat irregularity with atrial flutter is rare. AV nodal reentrant tachycardia (AVNRT), a specific type of paroxysmal supraventricular tachycardia (PSVT), is usually highly regular.

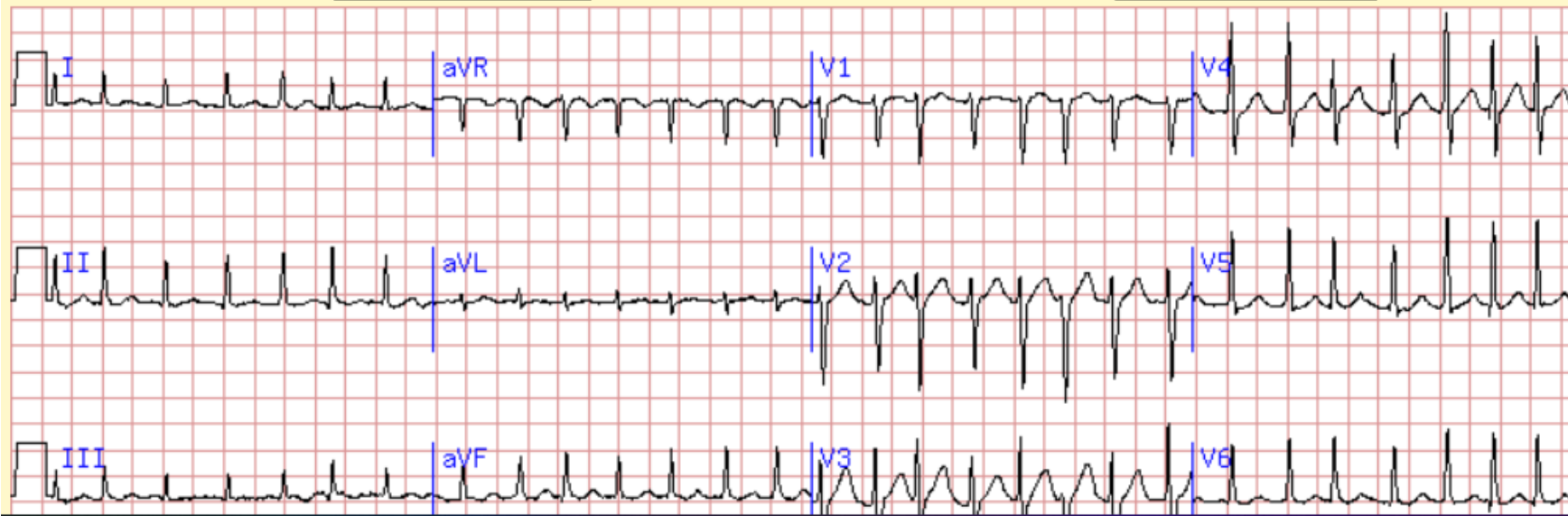
**Answer:** The initial therapy in patients with AF with a rapid ventricular response is directed at slowing the heart rate. This effect is usually accomplished by using drugs that slow impulse conduction through the AV node, such as calcium channel blockers (diltiazem, verapamil), beta-blockers, or digoxin, as well as by addressing underlying factors that enhance adrenergic tone (e.g., hyperthyroidism, fever, heart failure, etc).

For a detailed discussion of diagnostic and therapeutic considerations in AF, see:  
[http://www.acc.org/clinical/guidelines/atrial\\_fib/af\\_index.htm](http://www.acc.org/clinical/guidelines/atrial_fib/af_index.htm)

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**Question:** 89-year-old woman with tachycardia. What is the rhythm? (CLUE:Be careful!) \* \* \* *Difficulty rating*

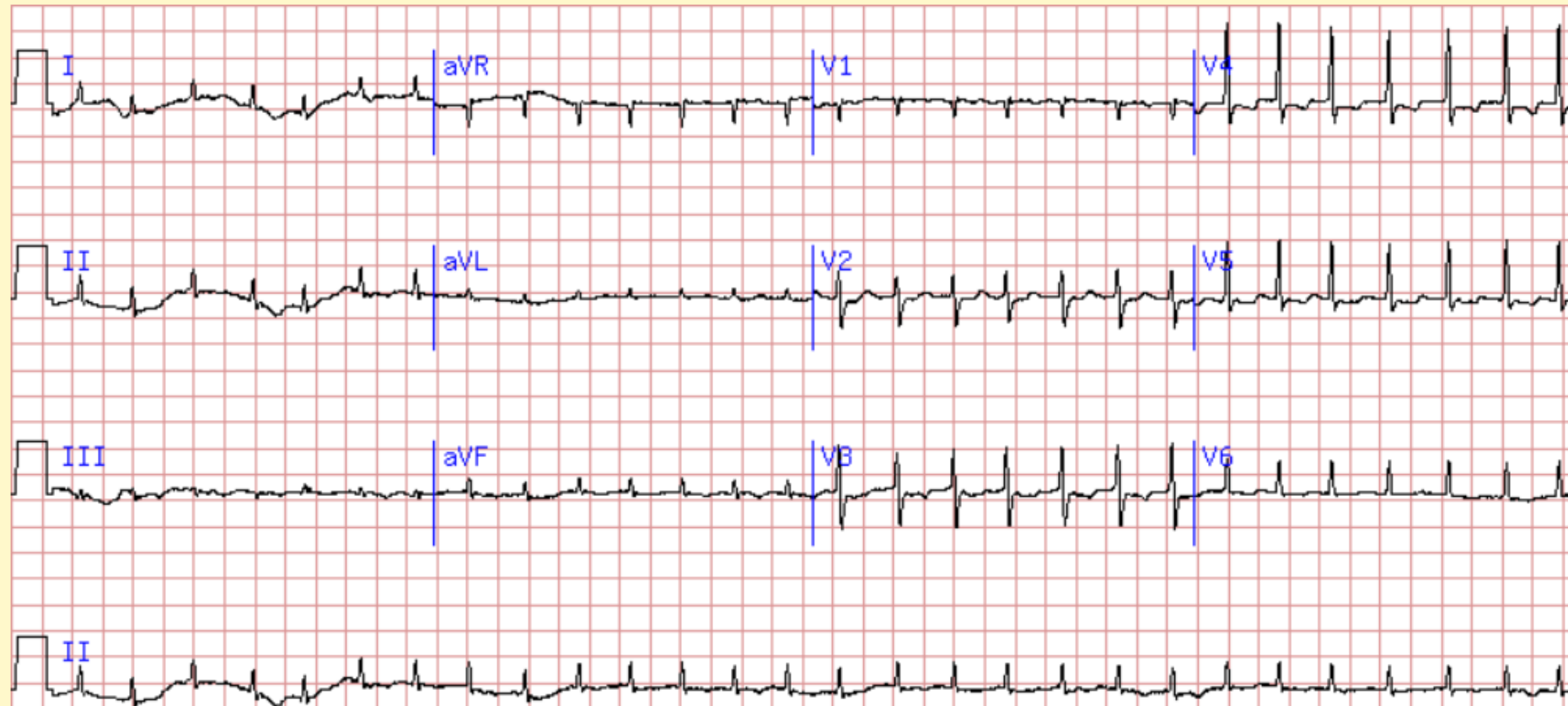
- a) Atrial fibrillation
- b) Multifocal atrial tachycardia
- c) PSVT due to AV nodal reentrant tachycardia (AVNRT)
- d) PSVT due to atrioventricular reentrant tachycardia (AVRT)
- e) Sinus tachycardia with atrial ectopy

**Your Answer:**

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**Question:** 89-year-old woman with tachycardia. What is the rhythm? (CLUE:Be careful!) \* \* \* *Difficulty rating*

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- e) Sinus tachycardia with atrial ectopy

Atrial fibrillation with a very rapid ventricular response (average 160-170/min).

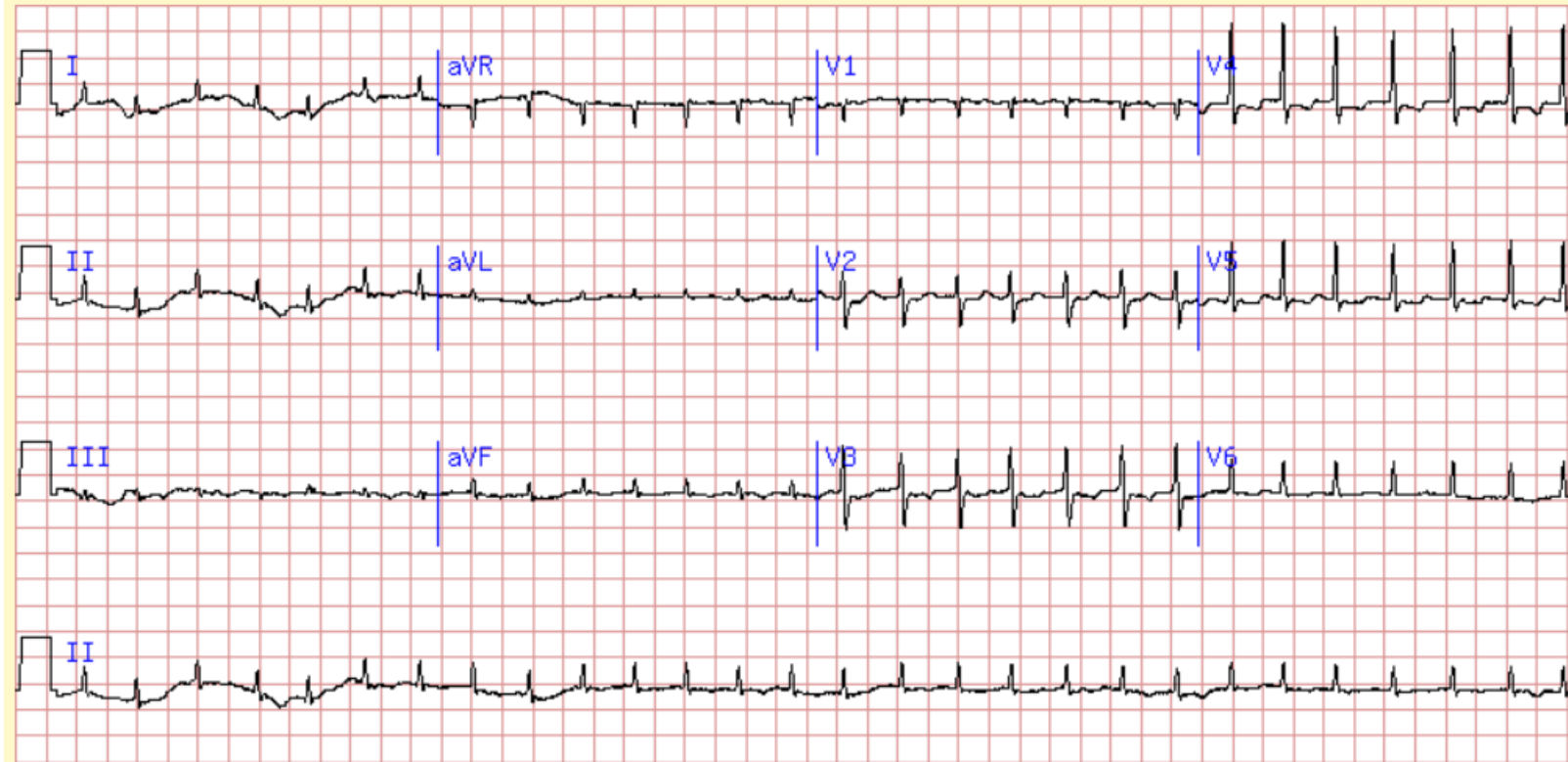
**Answer:**

Other Findings: Low limb voltage, minor RV conduction delay with rSr in V1; (or possibly Qr morphology) in lead V1 and non-specific ST-T changes (on digoxin) are also present. If so you said PSVT, go back and take another look. The rate here is subtly irregularly irregular (best seen when magnified at 200x or higher)--since rate is fast, small differences in RR intervals translate into prominent beat-beat variations (e.g., a change between R waves from 8 to 9 of the small (40 ms width) boxes would be 187 to 166/min change. Transient atrial flutter could also cause regularization of a rapid rate with atrial fibrillation. But the maximum atrial rate with atrial flutter is usually about 350/min. PSVT (esp with AVNRT) is usually metronomically regular.

[Hide Answer](#)

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**Question:** Elderly woman with an irregular pulse. What is the rhythm? What other abnormalities are present. \* \* \* *Difficulty rating*

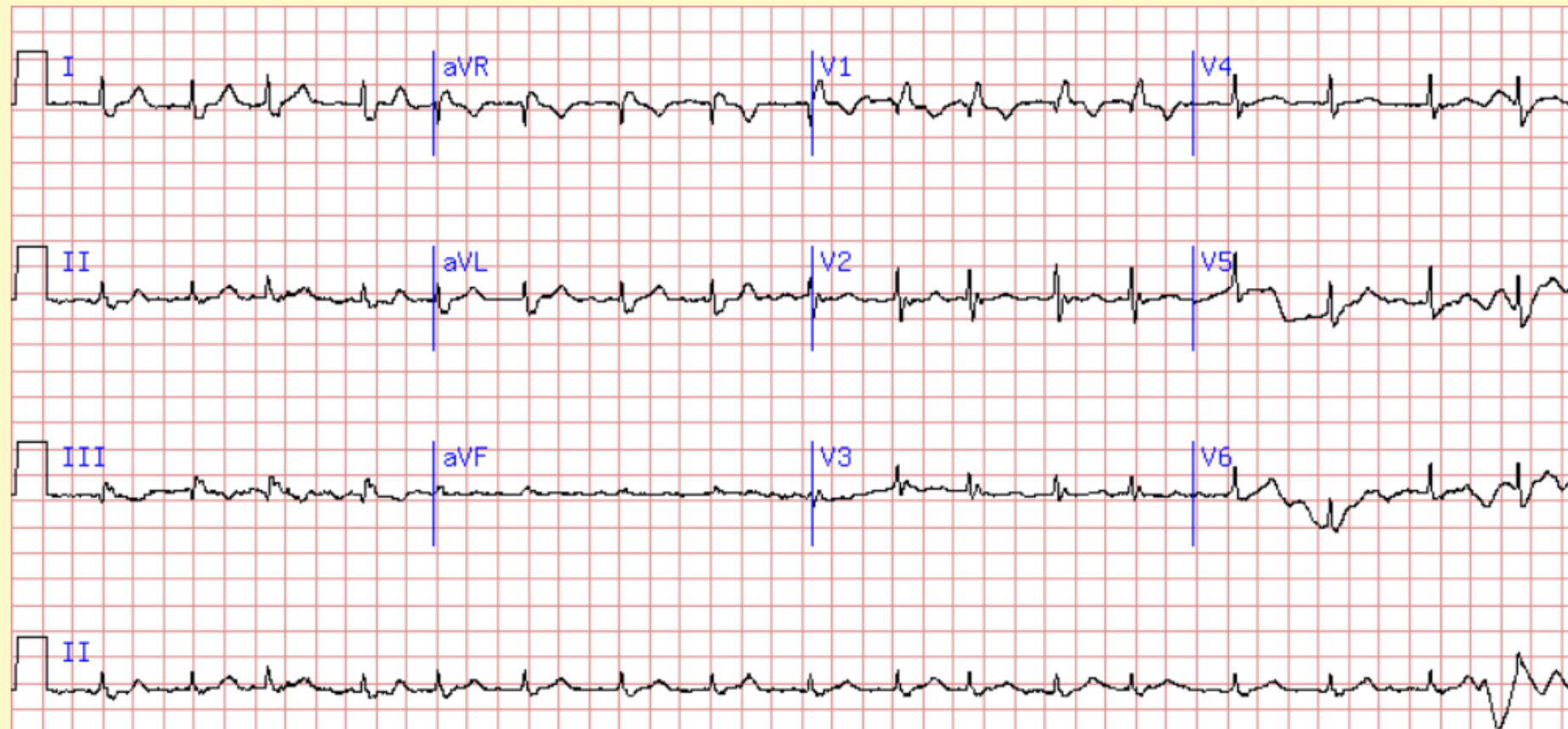
- a) Paroxysmal supraventricular tachycardia (PSVT)
- b) Sinus tachycardia with atrial ectopy
- c) Multifocal atrial tachycardia
- d) Atrial flutter with variable block
- e) Atrial fibrillation

**Your Answer:**

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**Question:** Elderly woman with an irregular pulse. What is the rhythm? What other abnormalities are present. \*\*\* *Difficulty rating*

- a) Paroxysmal supraventricular tachycardia (PSVT)
- b) Sinus tachycardia with atrial ectopy
- c) Multifocal atrial tachycardia
- d) Atrial flutter with variable block
- e) **Atrial fibrillation**

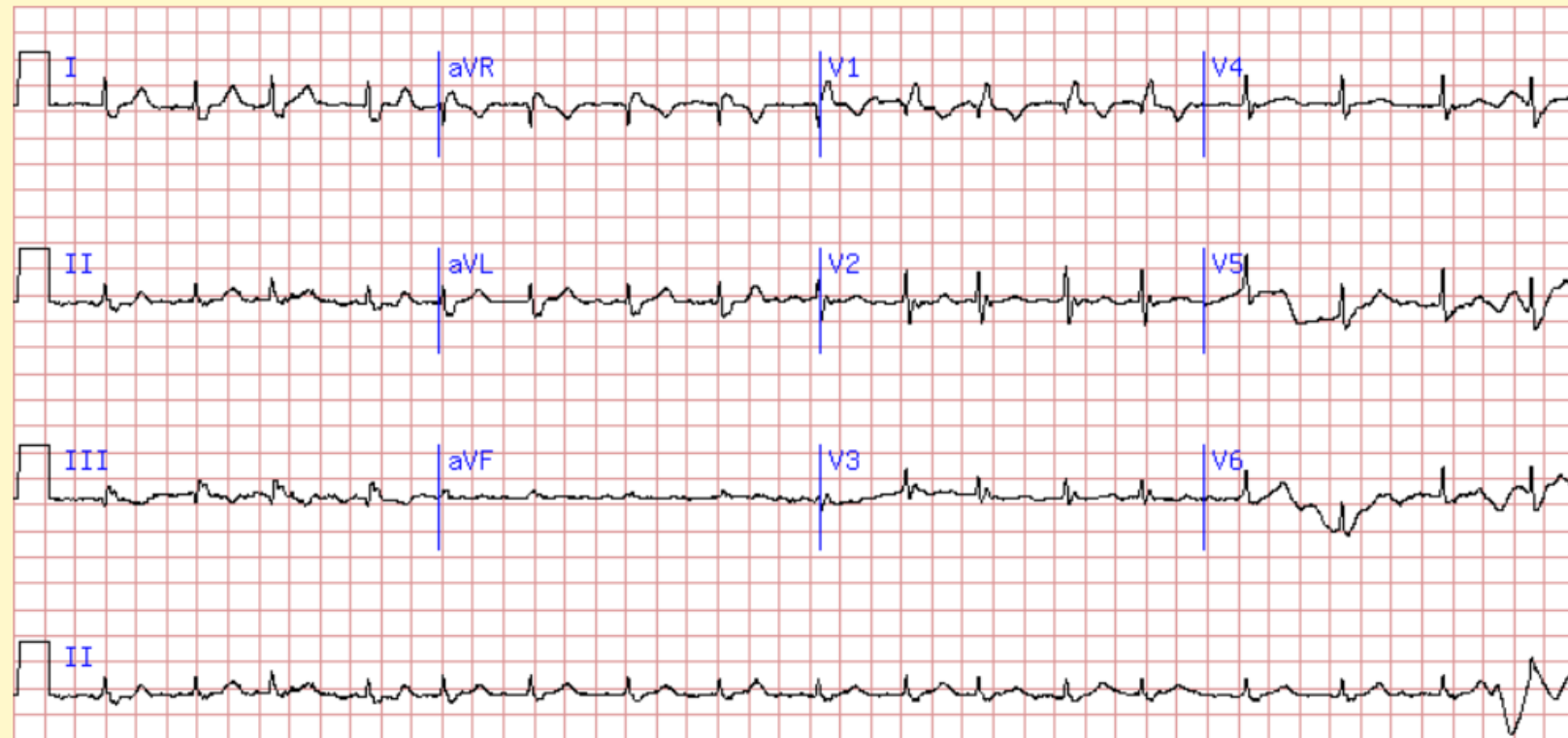
**Answer:**

The ECG shows baseline artifact (simulating a premature ventricular complex at the end of the recording). The rhythm is atrial fibrillation with a relatively rapid ventricular response at rest (mean about 100/min; range about 85 to 125/min). A complete right bundle branch block (RBBB) is present. The QRS voltage is relatively low diffusely. Non-specific ST-T changes are present. Note that the fibrillatory waves are relatively "fine" (low amplitude and high frequency) and may be missed entirely. At times higher amplitude "f" waves simulate sinus P waves. The ventricular rate may look regular at first glance, but if you measure the R-R intervals carefully, beat-by-beat, they are always changing. AF is one of the most commonly over- and under-diagnosed major arrhythmias.

[Hide Answer](#)

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**Question:** Tachycardia and a touch of cyanosis (rhythm and blues). What is major finding in this patient with congestive heart failure (CHF)? \*\*\* *Difficulty rating*

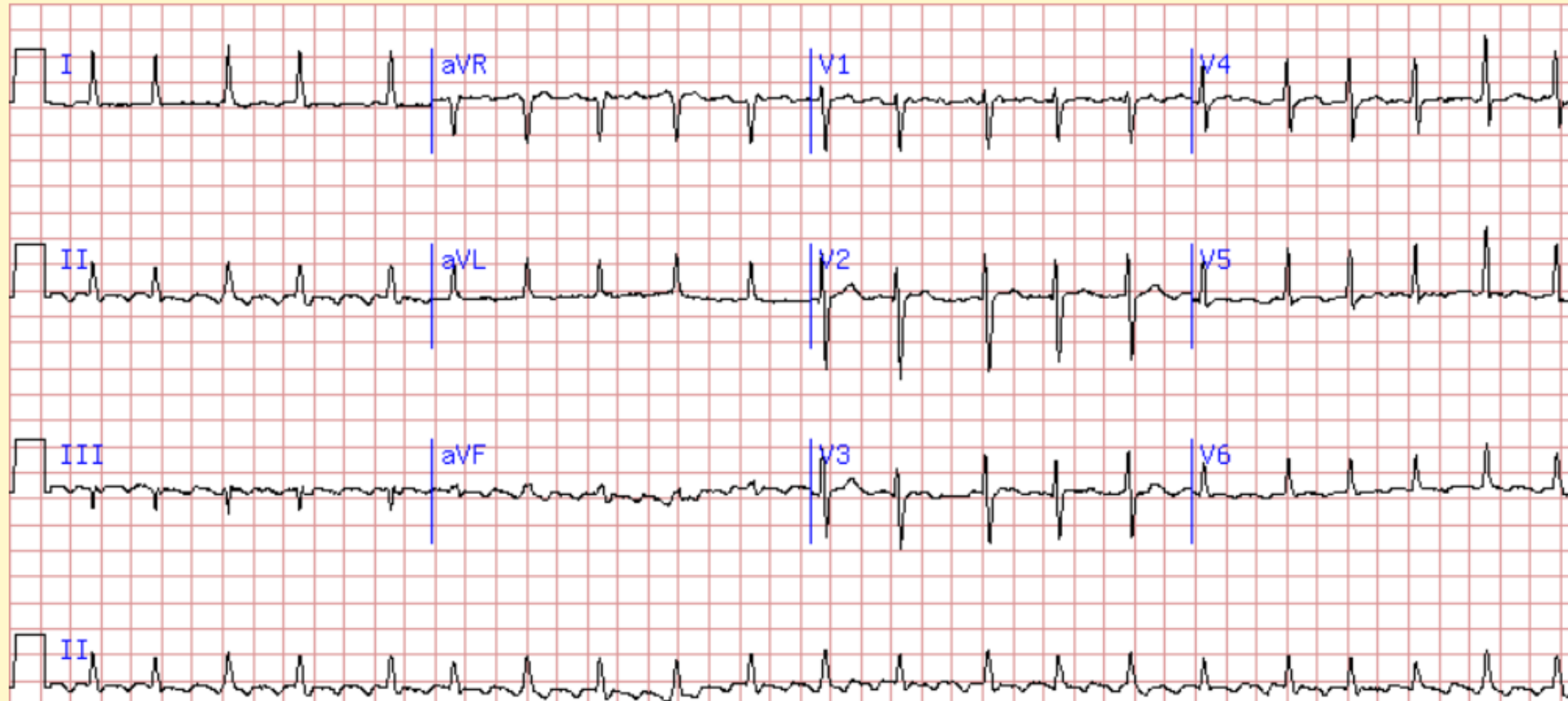
- a) Sinus tachycardia
- b) Atrial flutter
- c) Atrial fibrillation
- d) Multifocal atrial tachycardia
- e) Av nodal reentrant tachycardia (AVNRT)

**Your Answer:**

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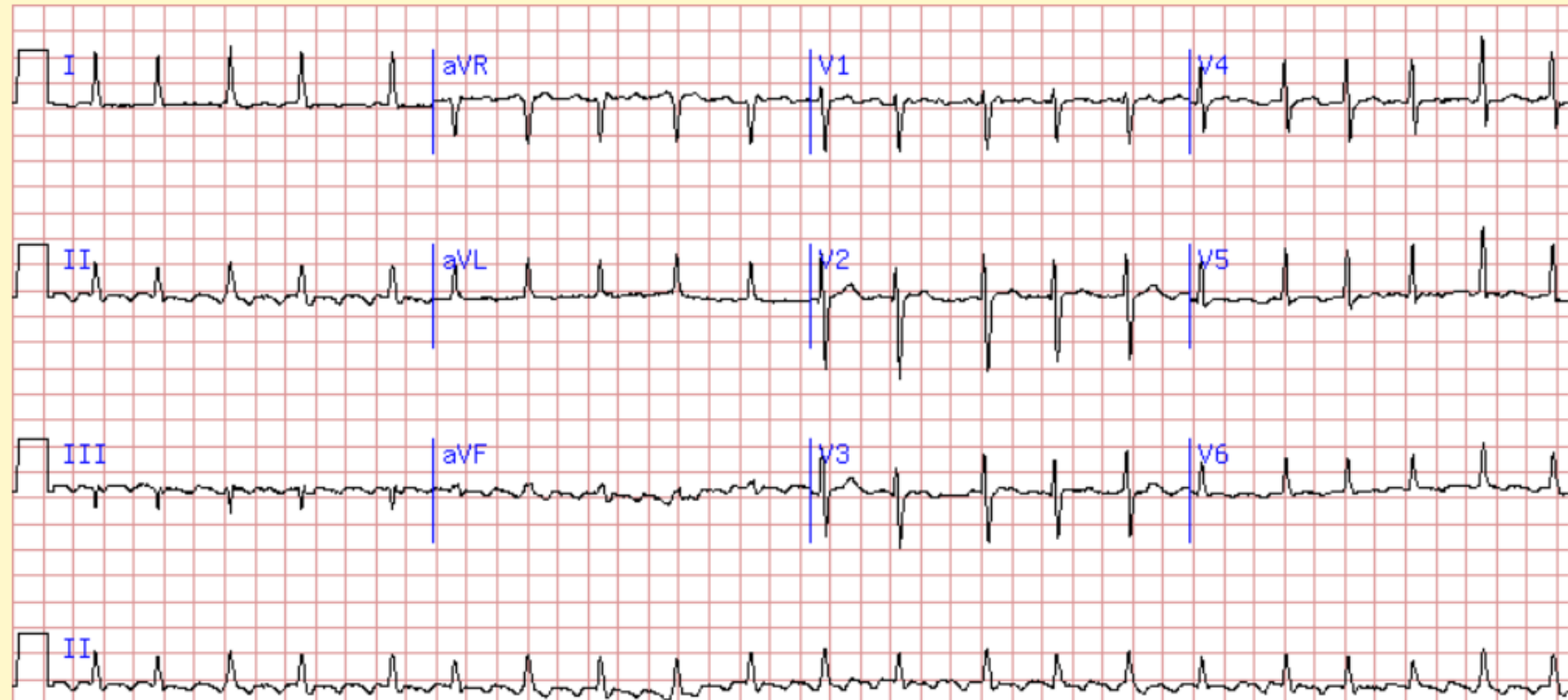
**Question:**

Tachycardia and a touch of cyanosis (rhythm and blues). What is major finding in this patient with congestive heart failure (CHF)? \*\*\* *Difficulty rating*

- a) Sinus tachycardia
- b) Atrial flutter**
- c) Atrial fibrillation
- d) Multifocal atrial tachycardia
- e) Av nodal reentrant tachycardia (AVNRT)

**Answer:**

The major finding is narrow complex tachycardia with atrial rate of about 300 indicating atrial flutter with a slightly variable ventricular response (2:1 conduction, some 3:1 and probably some AV Wenckebach). Atrial flutter is sometimes mistaken (by housestaff at institutions other than your own) for sinus tachycardia. Look, for instance, at V1 where the flutter waves are hard to see vs. lead II where they are more apparent. If only a V1 type lead were available, the mechanism could be readily mistaken.

[Hide Answer](#)[High Resolution Image](#)[PDF \(zoomable\) Image](#)

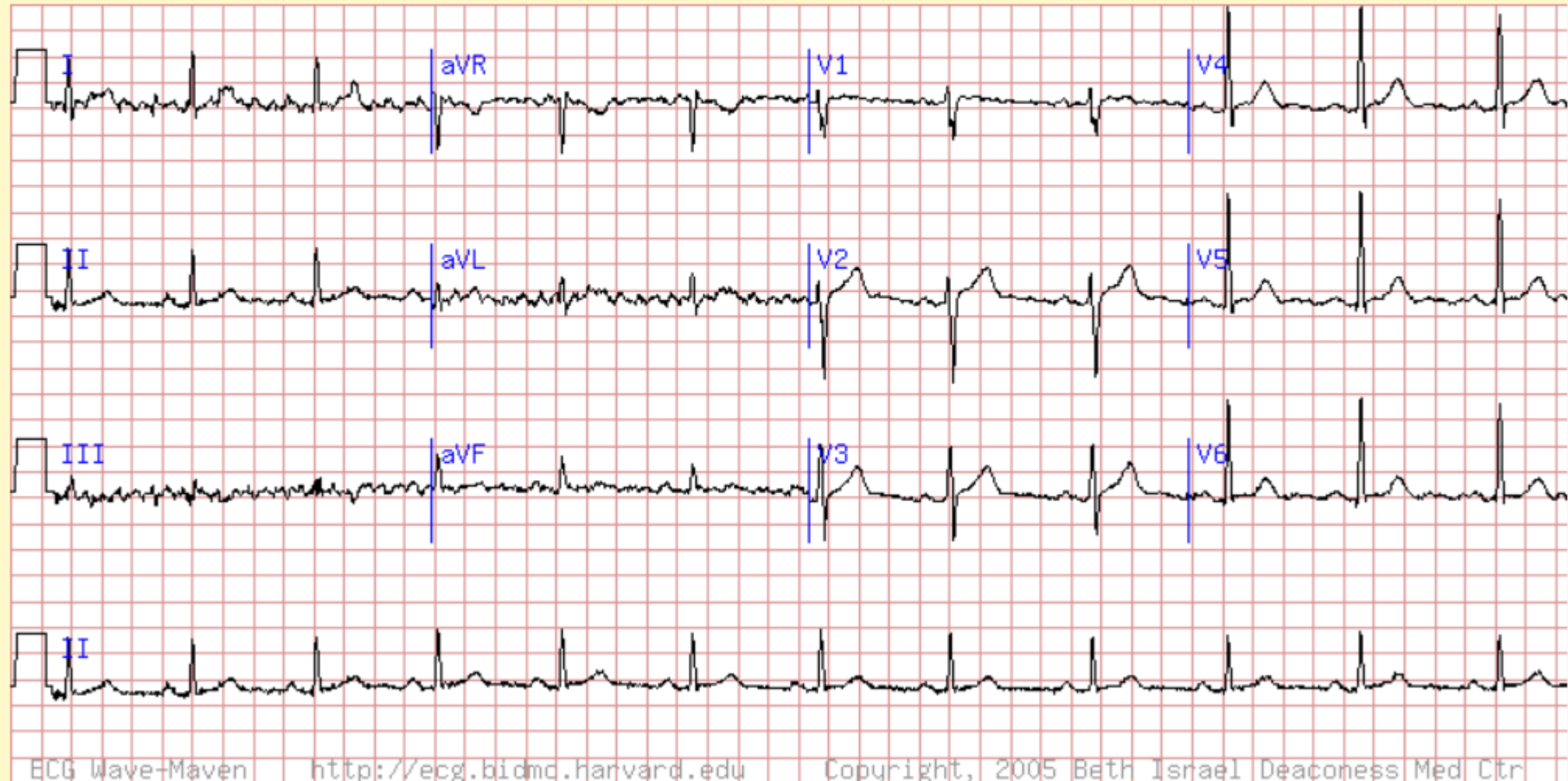
**Question:** 48-yr-old male: what service is patient on? \* \* *Difficulty rating*

**Answer:** Neurology/Neurosurgery. The patient has Parkinson's disease, with normal sinus rhythm. The clue is the tremor artifact, best seen in the limb leads. This artifact may sometimes be confused for atrial fibrillation/flutter, and when of very high magnitude may even look like torsades de pointes!

[Hide Answer](#)

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**Question:** 59-year-old female with sudden palpitations and lightheadedness. What is the rhythm? *Difficulty rating* \*\*\*

- a) Atrial fibrillation with WPW (Wolff-Parkinson-White) pre-excitation
- b) Ventricular tachycardia (monomorphic)
- c) Ventricular tachycardia (torsades de pointes)
- d) Atrial fibrillation with right bundle branch block aberrancy
- e) Tremor artifact with Parkinson's disease

**Your Answer:**

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**Question:** 59-year-old female with sudden palpitations and lightheadedness. What is the rhythm? \* \* \* \* *Difficulty rating*

- a) **Atrial fibrillation with WPW (Wolff-Parkinson-White) pre-excitation**
- b) Ventricular tachycardia (monomorphic)
- c) Ventricular tachycardia (torsades de pointes)
- d) Atrial fibrillation with right bundle branch block aberrancy
- e) Tremor artifact with Parkinson's disease

**Answer:**

The ECG shows a dramatic example of atrial fibrillation with the Wolff-Parkinson-White (WPW) syndrome, with conduction down the bypass tract. This rhythm is for the most part a wide complex tachycardia with a rate of about 230 beats/min. The differential diagnosis includes 1) ventricular tachycardia, 2) supraventricular tachycardia with aberrancy, and 3) WPW with conduction down the bypass tract. The major clues include the "irregularly irregular" rhythm and the extremely rapid rate. Ventricular tachycardia may be mildly irregular but this degree of irregularity would be unusual at this very fast rate. The short refractory period of certain bypass tracts can allow extremely rapid heart rates, especially during atrial fibrillation. A correct diagnosis is very important because drugs that slow AV conduction (verapamil, beta blockers, digoxin, adenosine) are not useful. Verapamil by vasodilation and reflex neuroautonomic changes may increase conduction down the bypass tract. The effects of digoxin are still controversial and this drug may shorten the refractory period of the bypass tract. Call cardiac EP experts stat! A drug of choice is IV procainamide and if this is unsuccessful, DC cardioversion should be performed promptly, if not otherwise contraindicated.

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**Question:** What arrhythmia is present in this wide-QRS-complex tachycardia? \* \* \* *Difficulty rating*

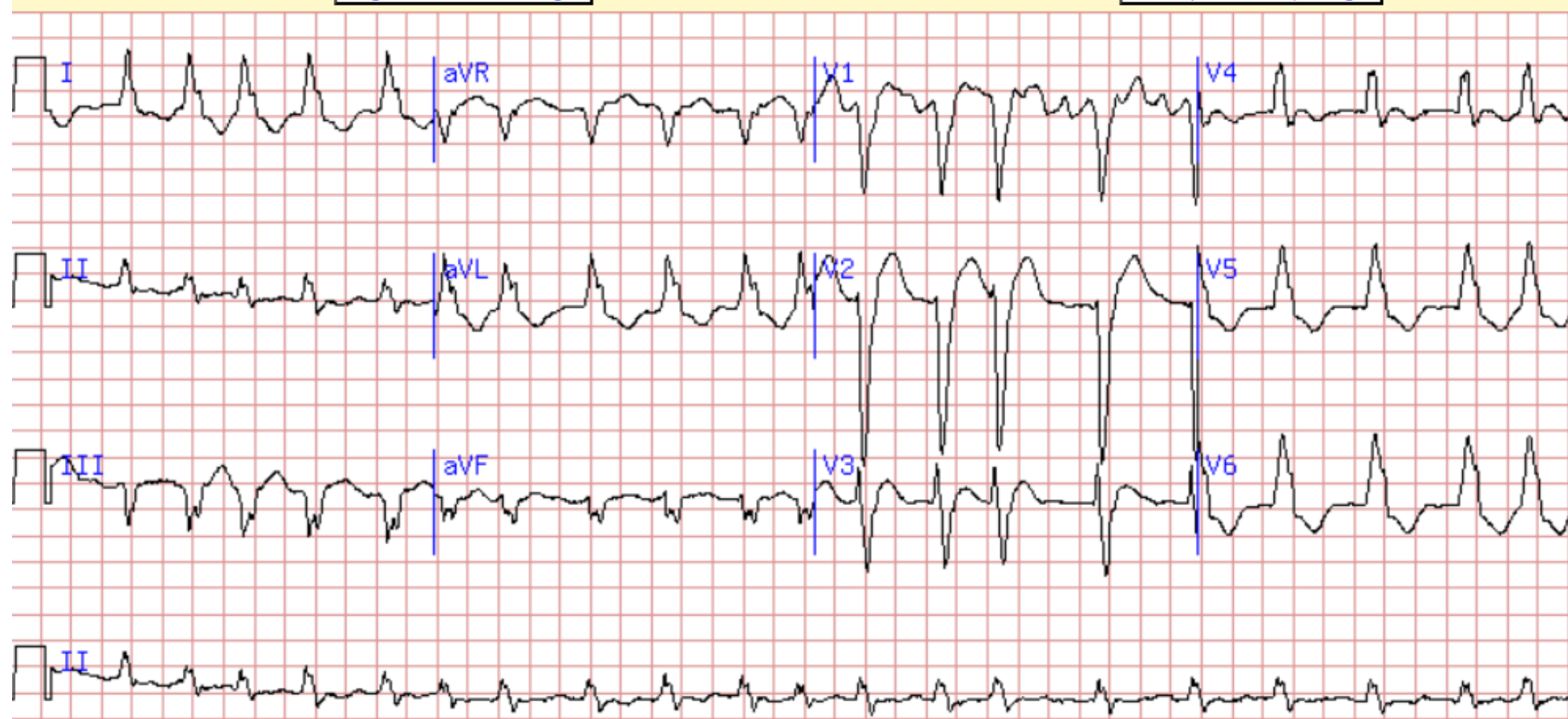
- a) Monomorphic ventricular tachycardia
- b) Polymorphic ventricular tachycardia
- c) Atrial fibrillation with left bundle branch block
- d) Atrial flutter with left bundle branch block
- e) Atrial fibrillation with Wolff-Parkinson-White pre-excitation

**Your Answer:**

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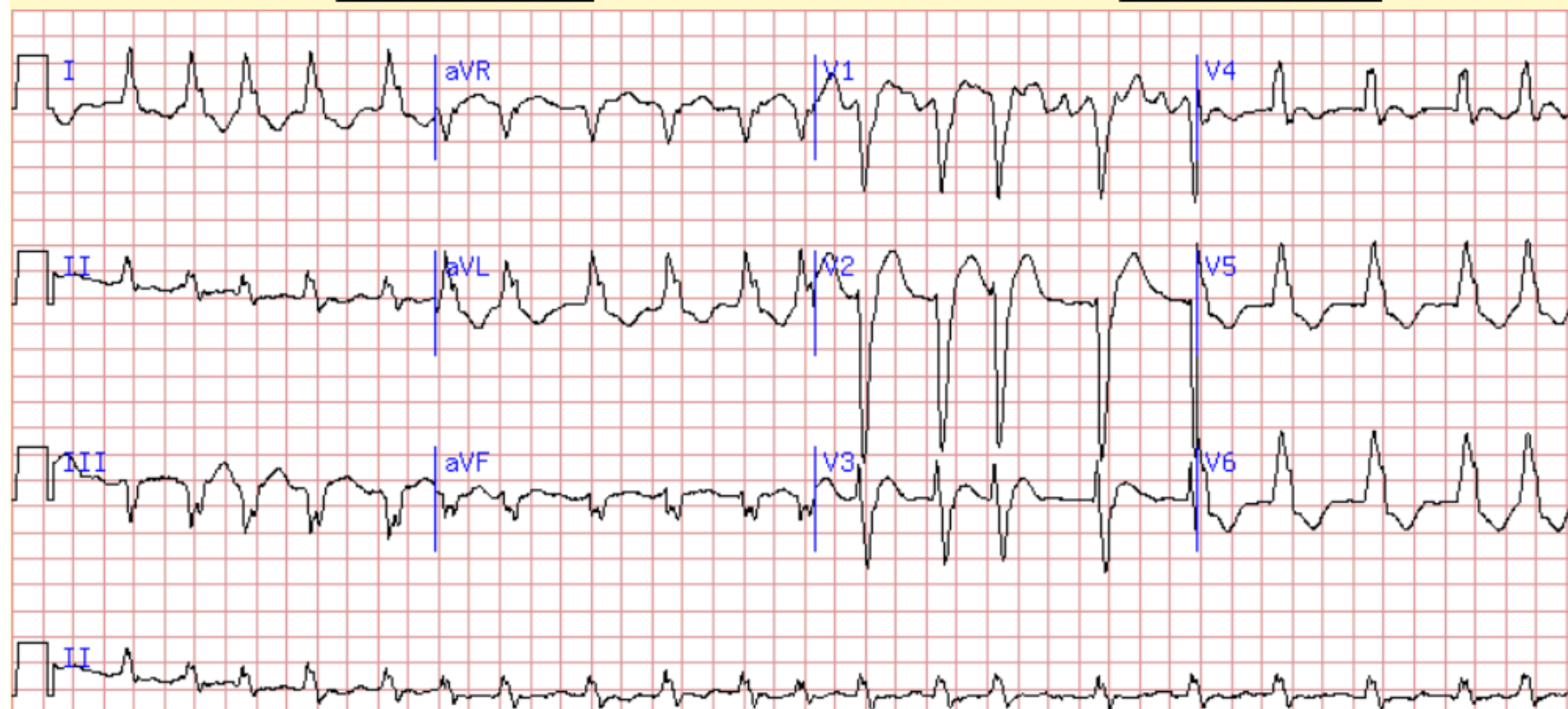
**Answer:**

c) Atrial fibrillation with left bundle branch block.~~Note: The coarse atrial fibrillatory waves (lead V1) may be mistaken for atrial flutter waves. However, with fibrillation (versus flutter) the atrial activity varies continuously and usually the ventricular response is completely variable. The QRS complex here shows a typical left bundle branch block morphology with secondary ST-T abnormalities.

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**Question:** 39-yr old-male in Medical Intensive Care Unit (MICU). What is the rhythm? \* \* \* *Difficulty rating*

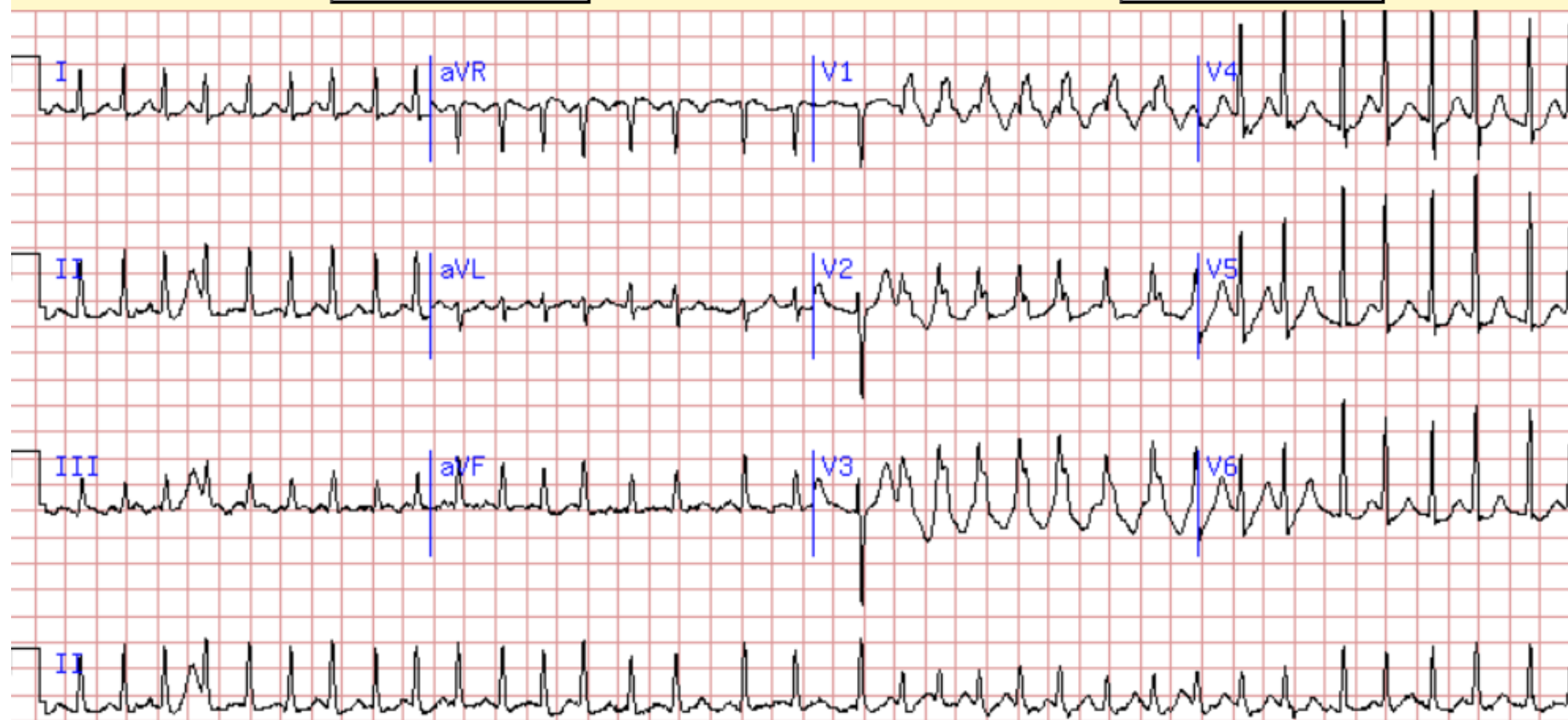
- a) Sinus tachycardia with non-sustained ventricular tachycardia
- b) Atrial fibrillation with transient right bundle branch aberrancy
- c) Paroxysmal supraventricular tachycardia with Wolff-Parkinson-White pre-excitation
- d) Multifocal atrial tachycardia with right bundle branch aberrancy
- e) Polymorphic ventricular tachycardia

**Your Answer:**

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**Question:** 39-yr old-male in Medical Intensive Care Unit (MICU). What is the rhythm? \* \* \* *Difficulty rating*

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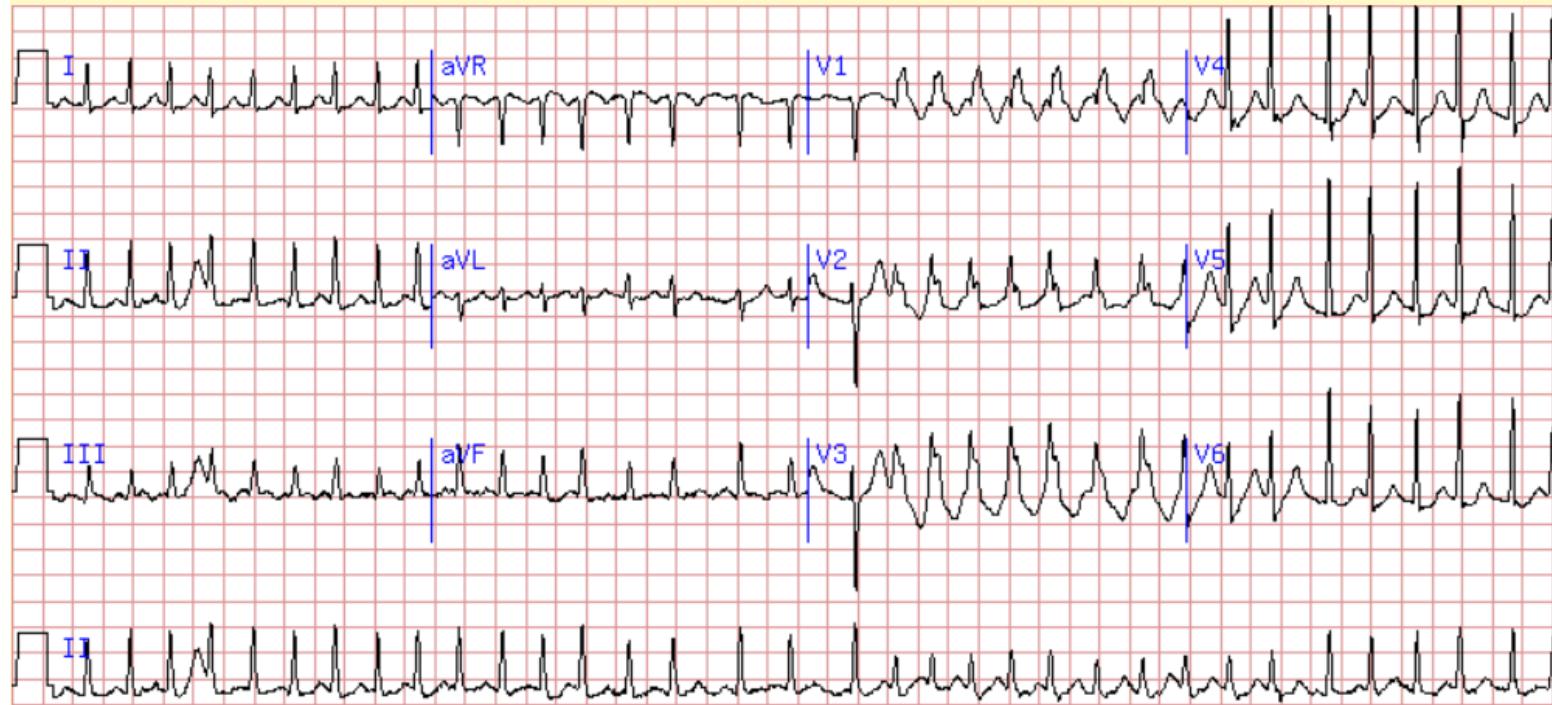
**Answer:**

Atrial fibrillation with an extremely rapid ventricular response (overall average about 204 beats per minute). There is intermittent right bundle branch block (RBBB) aberrancy (note QRS morphology in V1/V6, especially), associated with the very fast rates. In all, there are 10 consecutive beats with RBBB aberrancy, during which the ventricular response rate is up to 240 beats per minute. Transient right bundle branch (RBBB) aberrancy in the setting of atrial fibrillation is an example of the Ashman phenomenon. This type of aberrancy may occur as a single beat, mimicking an isolated premature ventricular complex (PVC) or as a run of wide-complex beats, as here, mimicking ventricular tachycardia (Gouaux JL, Ashman R. Auricular fibrillation with aberration simulating ventricular paroxysmal tachycardia. *Am Heart J* 1947:366–73). The initiation of the RBBB aberrancy in this context typically occurs with a long cycle-short cycle RR cadence, with the refractoriness of the right bundle related to the duration of the preceding RR interval. Thus, the first RBBB aberrancy beat is most likely to occur in the QRS that comes just after the relatively long RR interval.

[Hide Answer](#)

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**Question:**

85-year-old male without symptoms and on no pertinent cardiac medications. What is the rhythm here? \*\*\* *Difficulty rating*

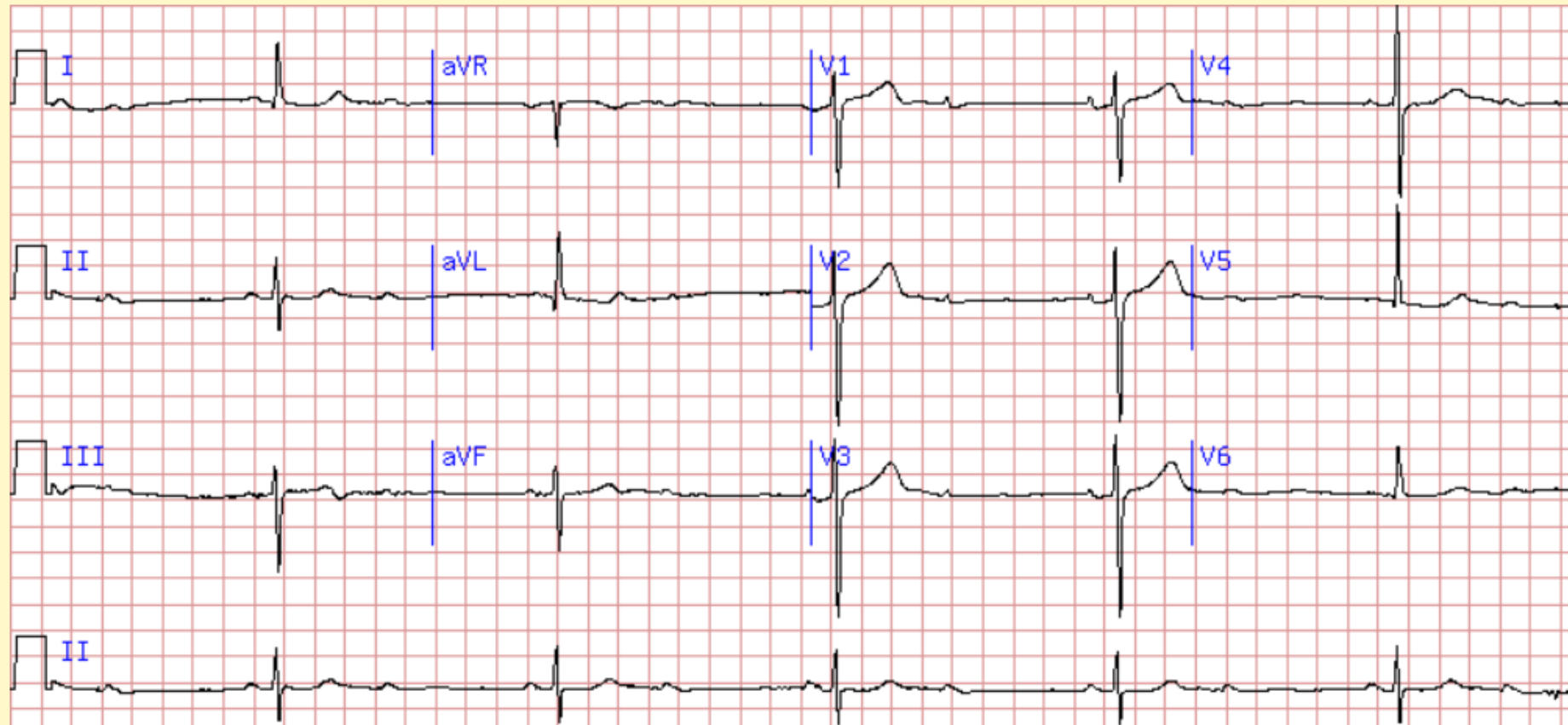
- a) Atrial tachycardia with AV block
- b) Sinus bradycardia (marked) consistent with sick sinus syndrome
- c) Sinus rhythm with 2:1 AV block
- d) Sinus rhythm with complete (third degree) AV block
- e) Sinus rhythm with 3:2 AV Wenckebach

**Your Answer:**

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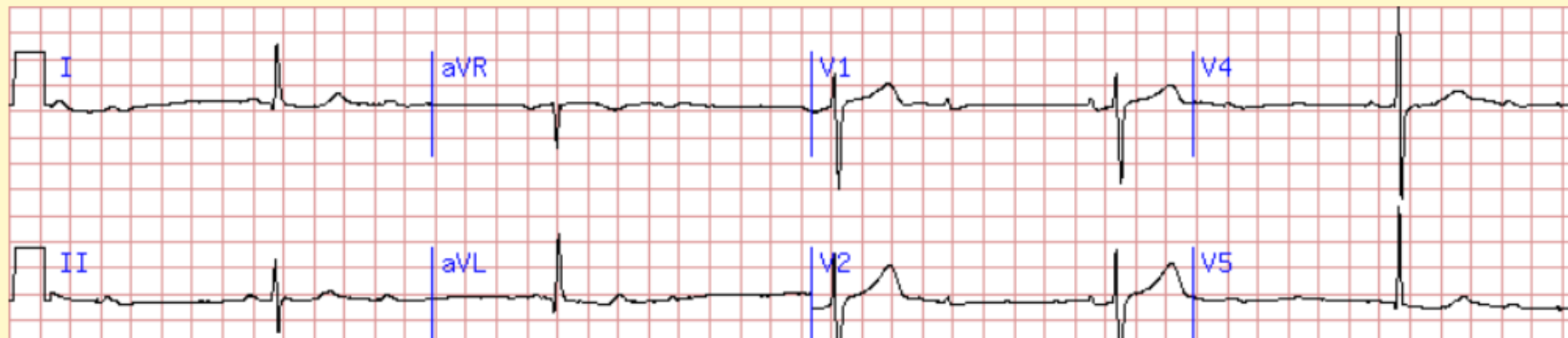
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85-year-old male without symptoms and on no pertinent cardiac medications. What is the rhythm here? \* \* \* *Difficulty rating*

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- c) **Sinus rhythm with 2:1 AV block**
- d) Sinus rhythm with complete (third degree) AV block
- e) Sinus rhythm with 3:2 AV Wenckebach

**Answer:**

The ECG shows a very slow ventricular rate (about 32/min) with non-conducted sinus P waves alternating with normally conducted P waves. The sinus (P) wave rate is about 64. The conducted PR intervals are constant at about 200ms. It is not possible to identify with certainty the location of block (nodal vs. infranodal) from this single ECG showing 2:1 AV conduction. The site of block could be proximal (in the AV node) or more distal, in the His-Purkinje system, especially intra-Hisian in this case given the narrow QRS. In general, with 2:1 block, involvement of the AV node is favored by a narrow QRS complex and a prolonged PR interval, or by the presence of intermittent AV Wenckebach. Block that is infranodal (in the His-Purkinje system) would be favored by a concomitant bundle branch block and/or a PR interval of 160 ms or less. Possibly useful bedside diagnostic tests for locating the site of chronic 2:1 block (in the absence of active ischemia) would include autonomic interventions. Sympathetic stimulation (e.g. by mild exercise) should increase heart rate and improve conduction with a nodal location of block, but worsen conduction in infra-nodal block. Carotid sinus massage (if not contraindicated) would decrease heart rate and worsen AV conduction in the case of nodal block but might improve AV conduction in infra-nodal block. Pacemaker placement is indicated for symptomatic 2:1 block at any site without a reversible cause (e.g., drug effect, Lyme disease) and for asymptomatic 2:1 block due to infranodal disease. Intracardiac His bundle electrograms would definitively locate the site of block. This patient had intermittent 3:2 AV Wenckebach at other times, and then resumed 1:1 conduction on subsequent ECGs, consistent with AV node disease. The ECG also shows left atrial abnormality, borderline left axis deviation and LVH by voltage, along with non-specific ST-T changes. The LVH could be from systemic hypertension, but always raises concern about aortic stenosis.

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**Question:**

What is the rhythm/AV relationship? \* \* \* *Difficulty rating*

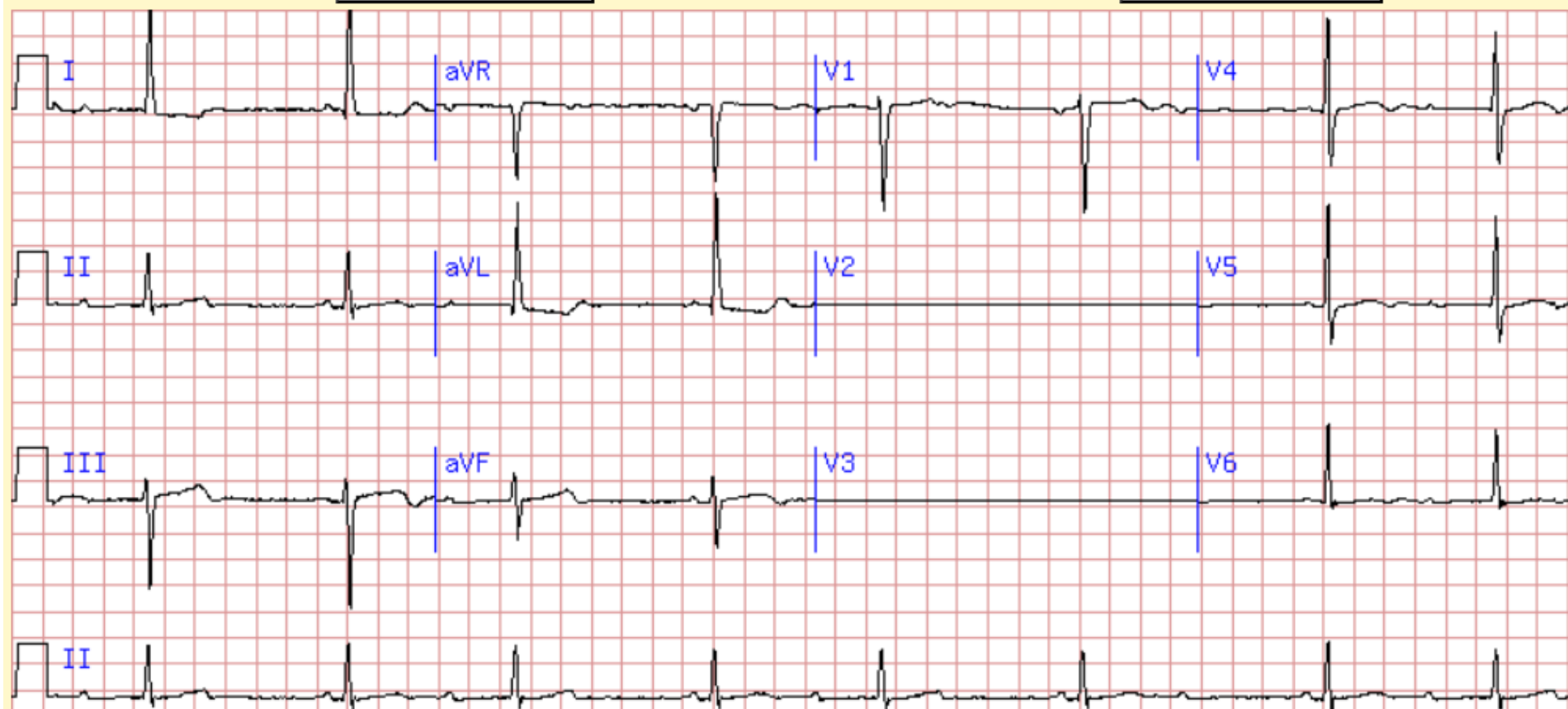
- a) Sinus rhythm with complete (third degree) heart block
- b) Sinus rhythm with AV Wenckebach and intermittent 2:1 AV block
- c) Sinus rhythm with 3:1 AV block
- d) Sinus rhythm with Isorhythmic AV dissociation
- e) Sinus rhythm with advanced second degree AV block

**Your Answer:**

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**Question:** What is the rhythm/AV relationship? \* \* \* *Difficulty rating*

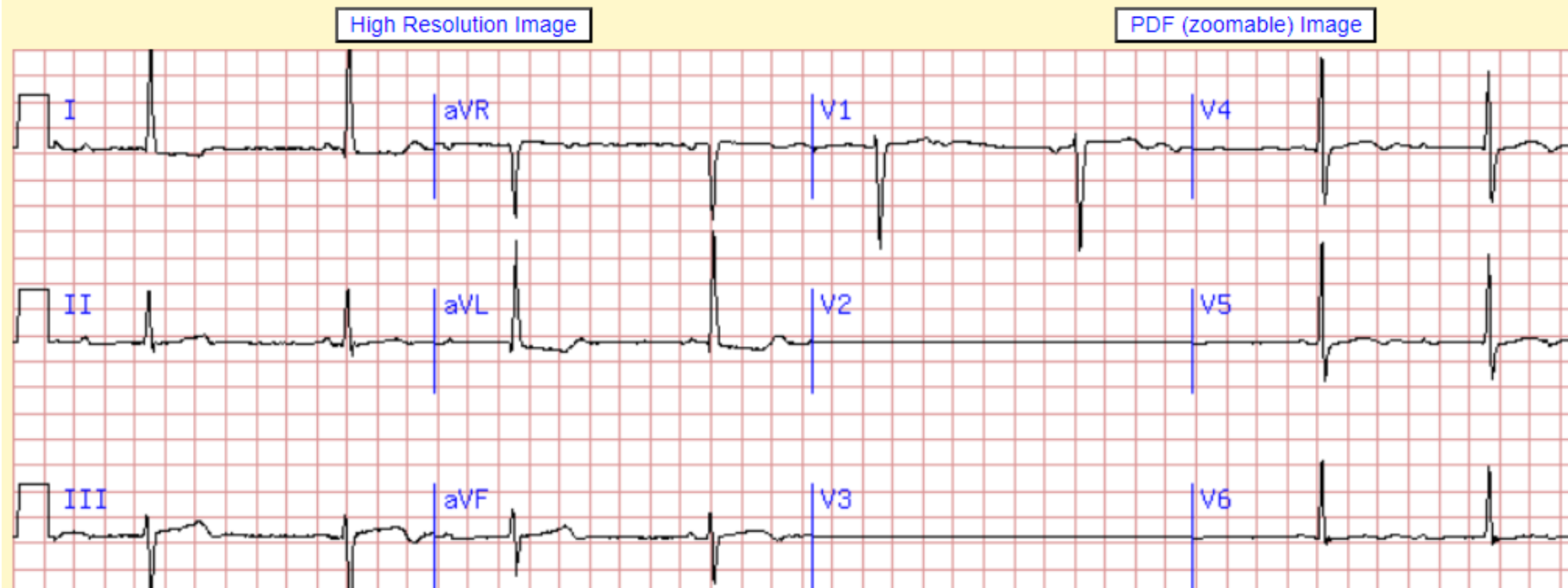
- a) Sinus rhythm with complete (third degree) heart block
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Sinus rhythm (P wave rate is 75/min) with AV Wenckebach (Type 1 AV block) is present with 3:2 conduction, along with 2:1 block. The effective ventricular rate is about 48/min. Notice the progressive PR prolongation in 3:2 cycles with non-conducted sinus P wave followed by a normal PR interval. Etiologies include drugs (beta-blockers, digitalis, calcium channel blockers), inferior ischemia, intrinsic AV node disease, Lyme disease, etc. In healthy young adults with high vagal tone (e.g. athletes), AV Wenckebach during sleeping hours is not uncommon. This patient's ECG also shows left ventricular hypertrophy (LVH), left atrial abnormality (LAA; prominent biphasic P wave with a broad negative component in V1) and infero-lateral T wave inversions raising question of ischemia superimposed on LVH pattern.

**Answer:**

Also note that the abrupt prolongation in "conductable" PR intervals raises consideration of underlying dual pathway physiology in the AV node.

[Hide Answer](#)



**Question:** ECG from a young adult with bradycardia. The findings are most consistent with which scenario? \* \* \* \* *Difficulty rating*

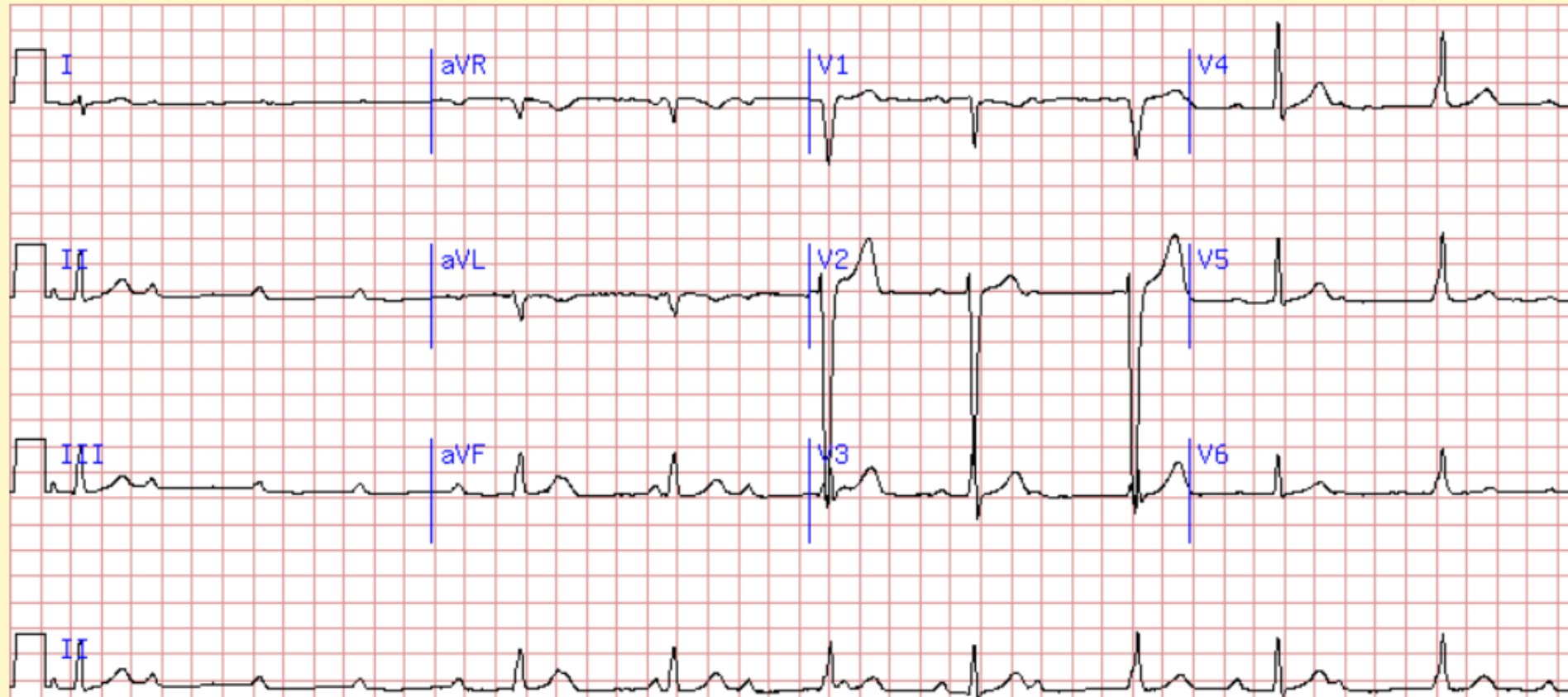
- a) Severe chest pain
- b) Sick sinus syndrome
- c) Cape Cod camper
- d) Tricyclic overdose
- e) "Athlete's heart" and physiologic increase in vagal tone

**Your Answer:**

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**Question:** ECG from a young adult with bradycardia. The findings are most consistent with which scenario? \* \* \* \* *Difficulty rating*

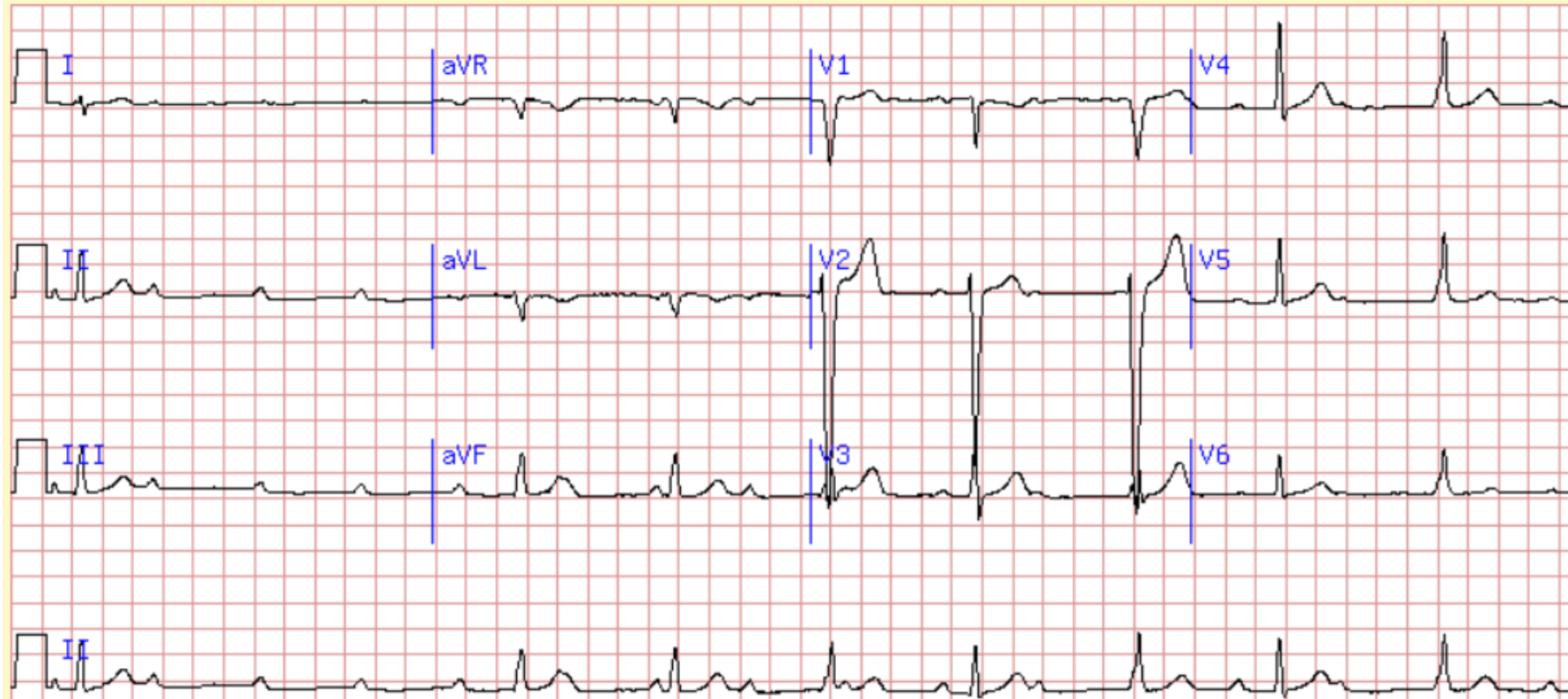
- a) Severe chest pain
- b) Sick sinus syndrome
- c) **Cape Cod camper**
- d) Tricyclic overdose
- e) "Athlete's heart" and physiologic increase in vagal tone

**Answer:** c) The patient had Lyme carditis. Sinus rhythm is present with advanced second-degree AV block and possible transient complete heart block. Several non-conducted P waves are seen at the beginning of the recording. Some of the P waves later on appear to be conducted; although, complete heart block is not excluded.

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**Question:** Elderly woman with lightheadedness and slow pulse. What is the rhythm? (Note the baseline artifact.) \*\*\* *Difficulty rating*

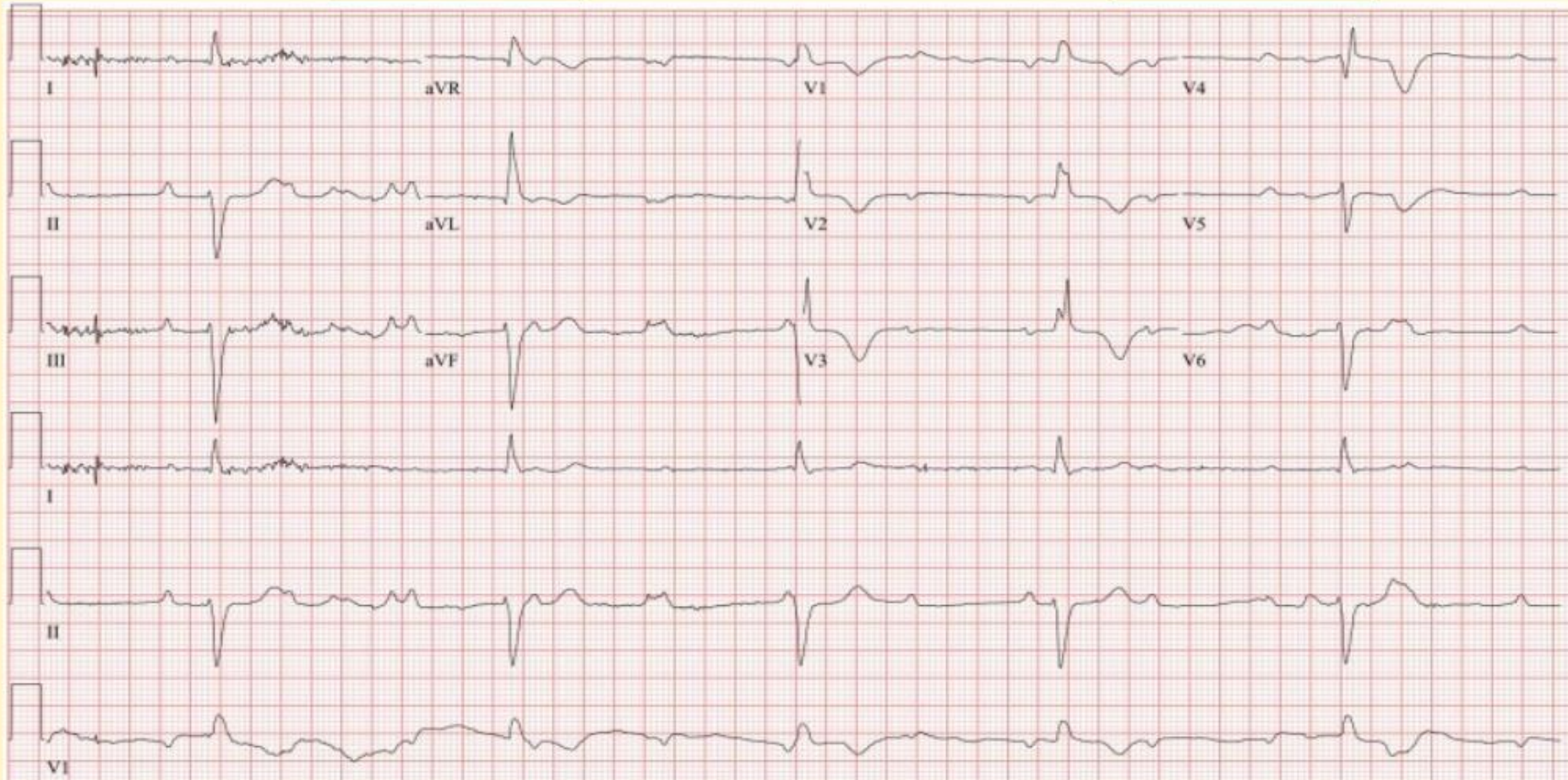
- a) Sinus rhythm with AV Wenckebach (Mobitz I) variant
- b) Sinus rhythm with complete AV block
- c) Sinus rhythm isorhythmic AV dissociation and junctional escape
- d) Sinus rhythm with predominant 2:1 AV block
- e) Sinus rhythm with advanced (including 3:1) second degree AV block

**Your Answer:**

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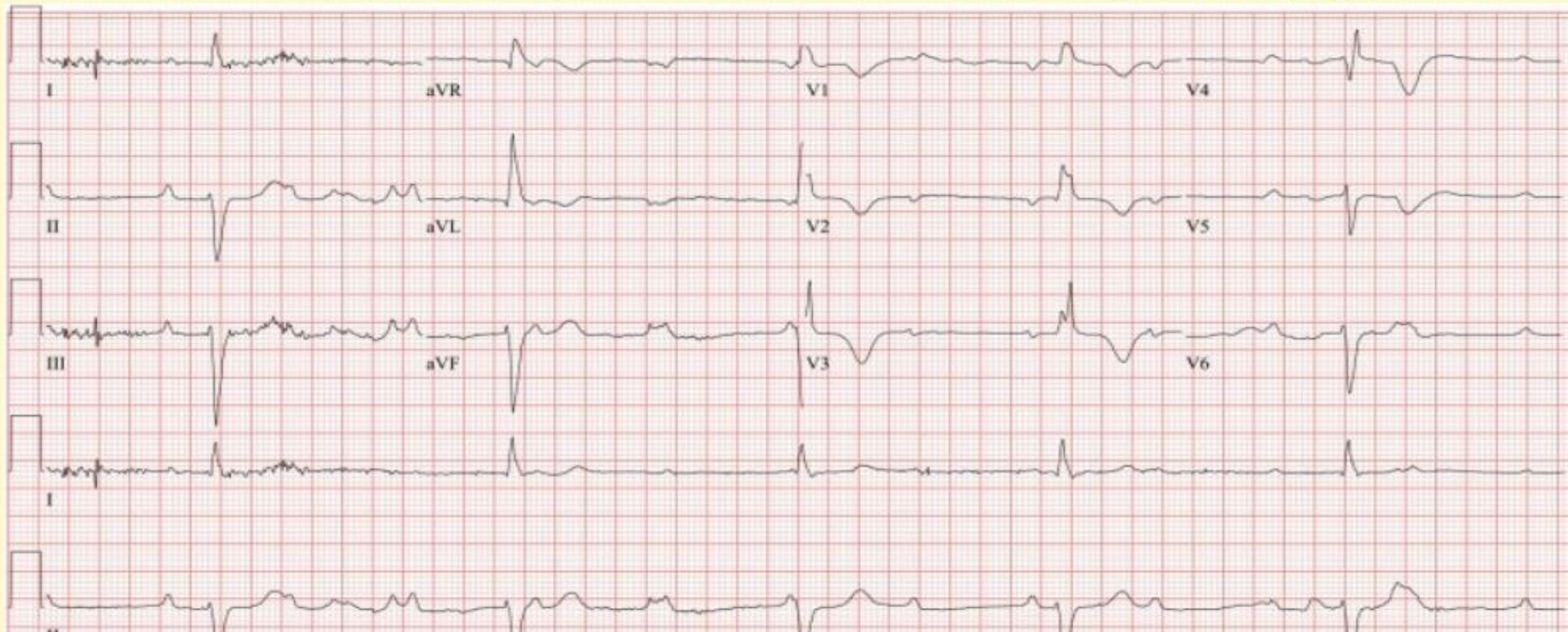
**Answer:**

Sinus rhythm (with artifact) is present at an atrial rate of about 75/min (with possible biatrial abnormality), well seen in lead II and V1 rhythm strips. Complete AV block is present with an escape pacemaker at a regular rate of about 33 beats/min. No relationship exists between the P waves and QRS complexes. The wide QRS complexes have a right bundle branch block/left anterior fascicular block morphology consistent with severe infra-nodal disease. Prior anterior MI cannot be excluded. There is probable left ventricular hypertrophy (history of hypertension; not aortic stenosis). The prominent T wave inversions may associated with high-degree AV block, and/or due to ischemia/MI, etc. Cardiac enzyme biomarkers for acute MI were negative. No reversible causes of AV block were found. The patient underwent dual chamber pacemaker implantation.

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**Question:** What is the rhythm in a 42 year old woman with palpitations? \* \* \* *Difficulty rating*

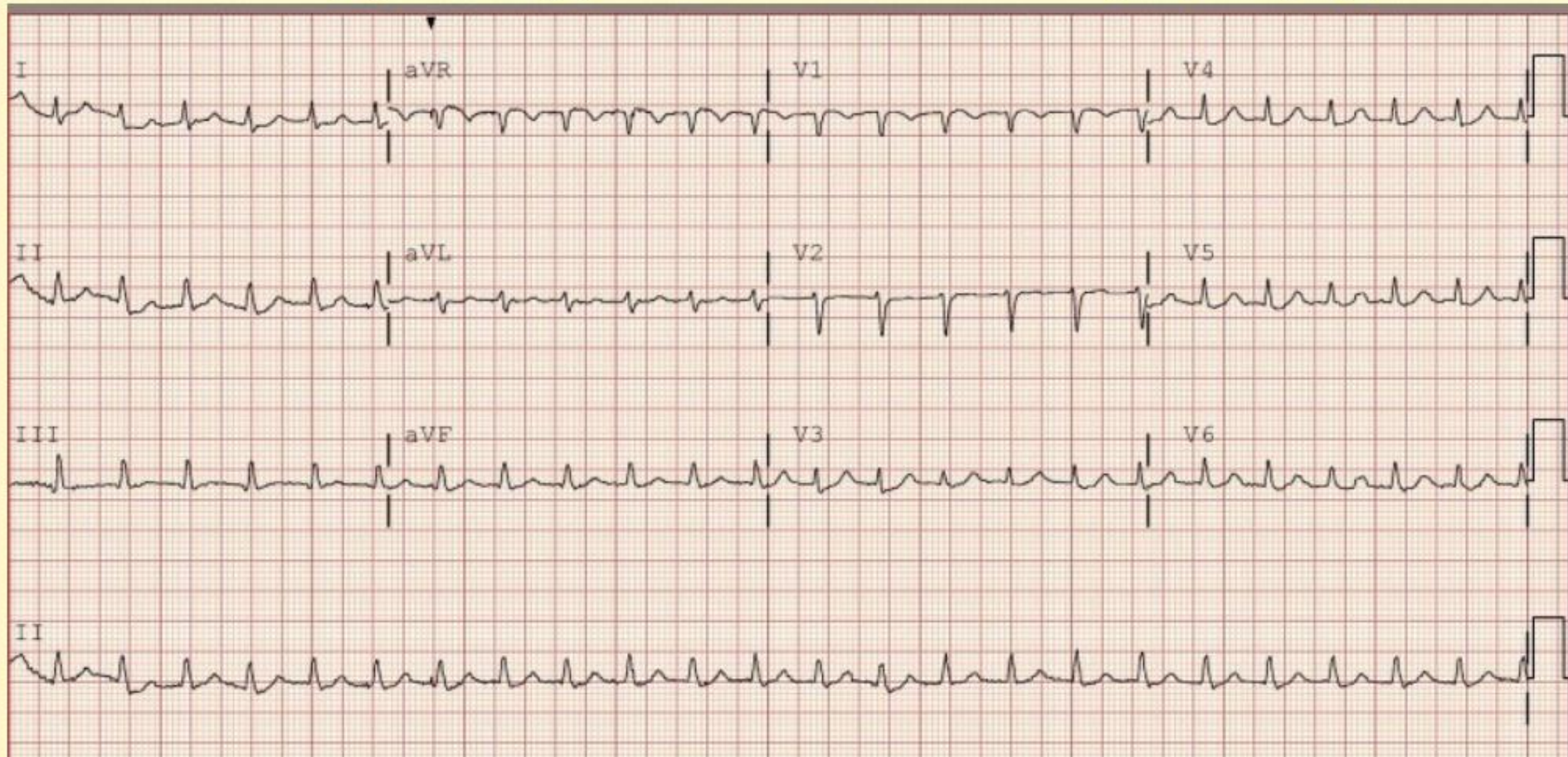
- a) Sinus tachycardia
- b) Paroxysmal supraventricular tachycardia (PSVT) due to probable AV nodal reentrant tachycardia (AVNRT)
- c) Atrial flutter with 2:1 conduction
- d) Atrial fibrillation with regularized ventricular response
- e) PSVT with atrio-ventricular reentrant tachycardia (AVRT) and antidromic conduction (i.e., down the bypass tract)

**Your Answer:**

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- e) PSVT with atrio-ventricular reentrant tachycardia (AVRT) and antidromic conduction (i.e., down the bypass tract)

The ECG shows a very regular, narrow complex tachycardia (NCT) with a ventricular rate of about 150/min. The NCT rules out antidromic conduction with a concealed bypass tract, which should produce a wide-complex tachycardia. If you look carefully, especially at a magnified high resolution presentation of this ECG, you will see subtle positive/negative deflections near the terminal part of the QRS in leads aVR/II, consistent with retrograde P waves from AV nodal reentry. These waves are sometimes called pseudo-R and pseudo-S waves, respectively. The low voltage QRS complexes were likely due to obesity.

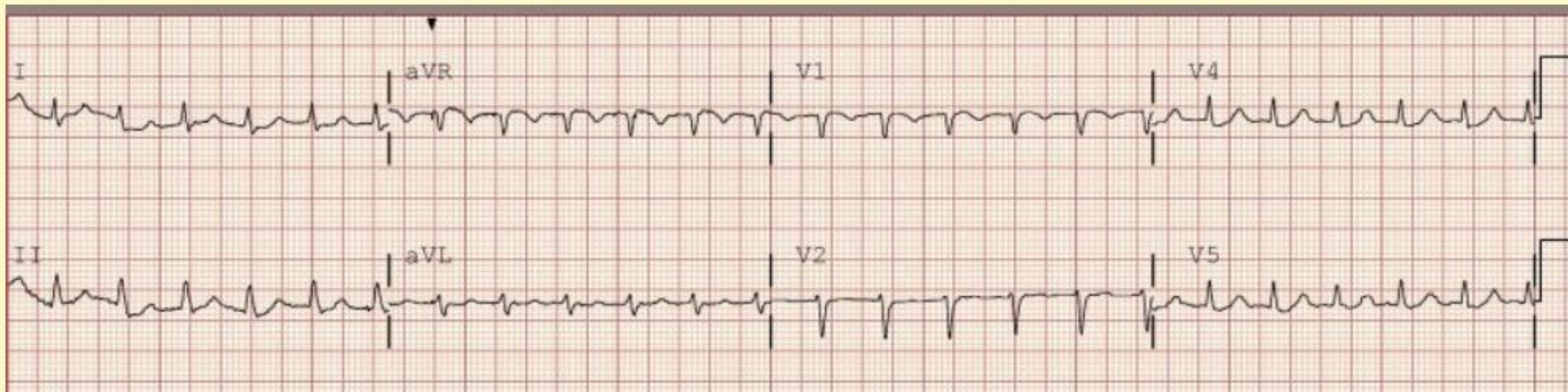
**Answer:**

The substrate for AVNRT relates to so-called "dual-pathways" in the AV node that allow for the initiation and maintenance of a reentrant type rhythm. Typically AVNRT is initiated by an atrial premature complex. The retrograde P waves during the tachycardia may be seen just after the QRS, as in this case, or may be "hidden" in the QRS if the atria and ventricles are stimulated simultaneously. Rarely, the retrograde P waves with AVNRT will precede the QRS. See other examples of NCTs on this site for further discussion (e.g., 106, 278, 323, 390). Also, see the very nice review by Drs. Katritsis and Camm in *Circulation*: <http://circ.ahajournals.org/content/122/8/831.full>

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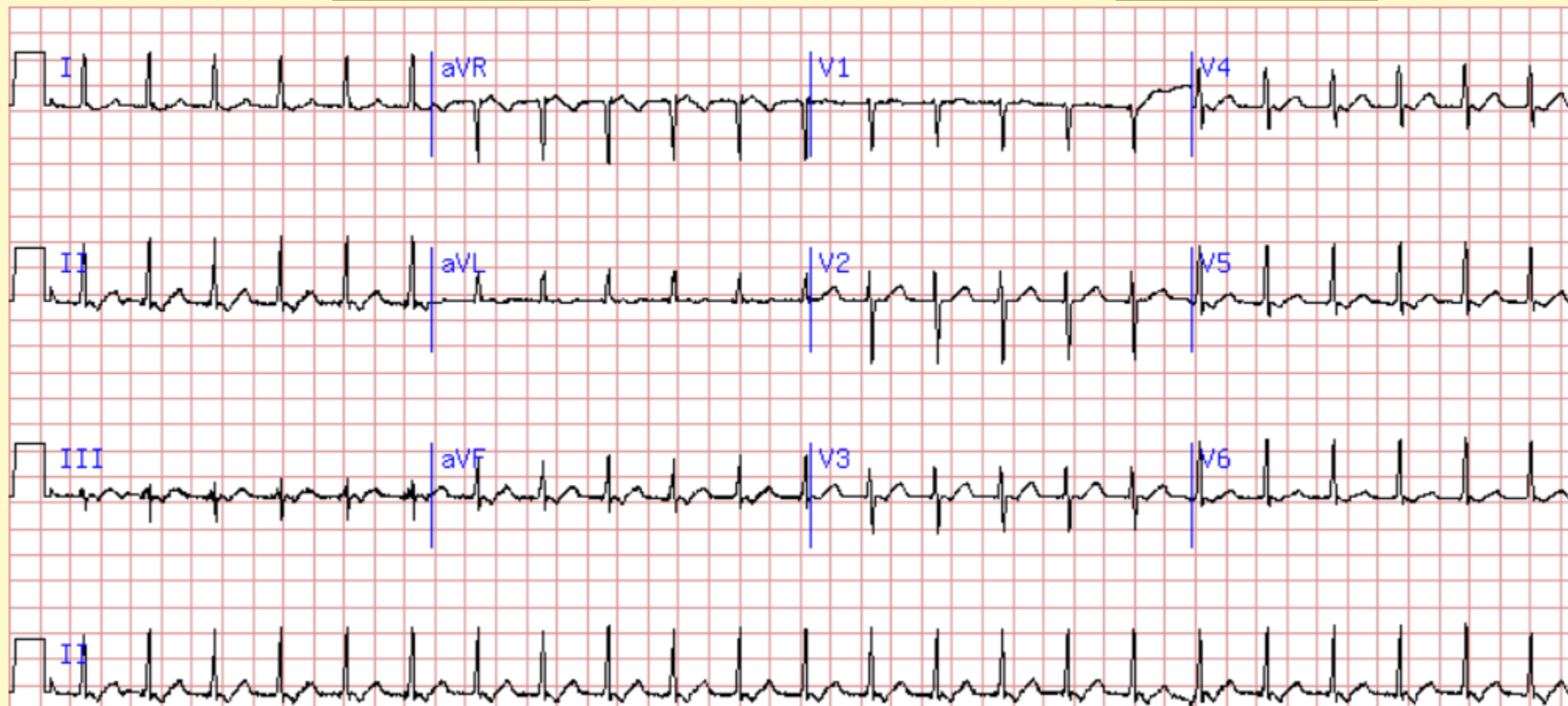
**Question:** 51-year-old female with post-operative palpitations (first and only episode). Reversion to sinus rhythm occurred after IV adenosine. What is major differential diagnosis? \* \* \* \* *Difficulty rating*

**Your Answer:**

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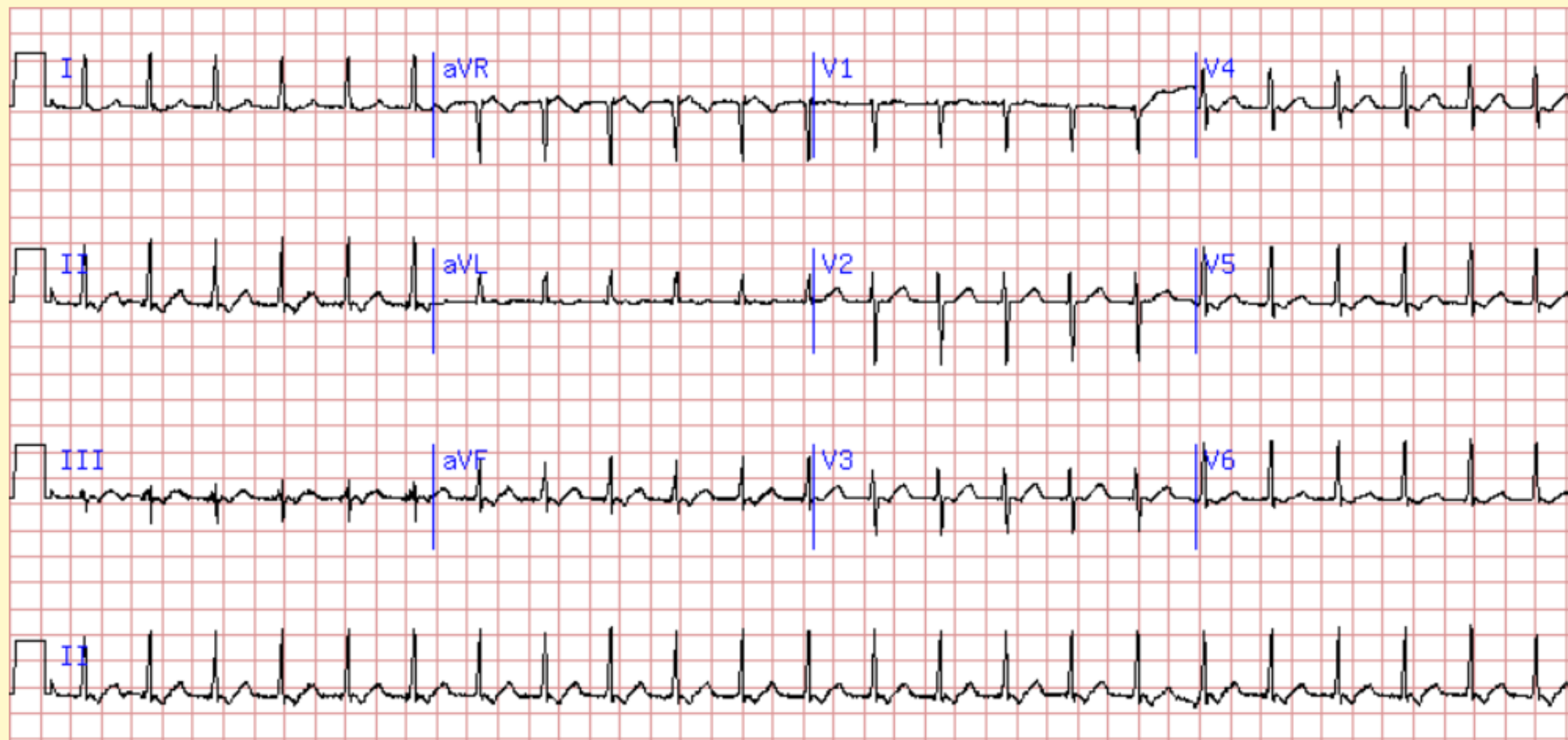


**Question:**

51-year-old female with post-operative palpitations (first and only episode). Reversion to sinus rhythm occurred after IV adenosine. What is major differential diagnosis? \* \* \* \* *Difficulty rating*

**Answer:**

The findings are that of a reentrant type PSVT. Note the inverted P waves in leads II, III, and F; with upright P waves in aVR, consistent with retrograde activation of the atria from region in or near the AV node. Somewhat atypically for AVNRT, the P waves are located in the ST segment proper, not hidden in the QRS or just after the QRS. However, most likely this is still an AV nodal reentrant tachycardia variant with somewhat slow conduction in the retrograde ("fast pathway") limb. AV reentrant tachycardia (AVRT) involving a concealed bypass tract in the septal area is possible. The clinical setting (single event in middle-aged woman) favors AVNRT. The ECG, by itself, could represent either mechanism. Adenosine response (which blocks the reentrant circuit in the AV node) does not distinguish between response to AVNRT or AVRT. Definitive answer would likely call for EP study, not indicated by the present clinical scenario, but would be consideration for recurrent, symptomatic episodes. Compare with other examples of PSVT on the site. (Revised: 4/20/2020.)

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**Question:**

60 year old woman with palpitations and rapid pulse at rest. The ECG shows which one of the following arrhythmias? \*\*

*Difficulty rating*

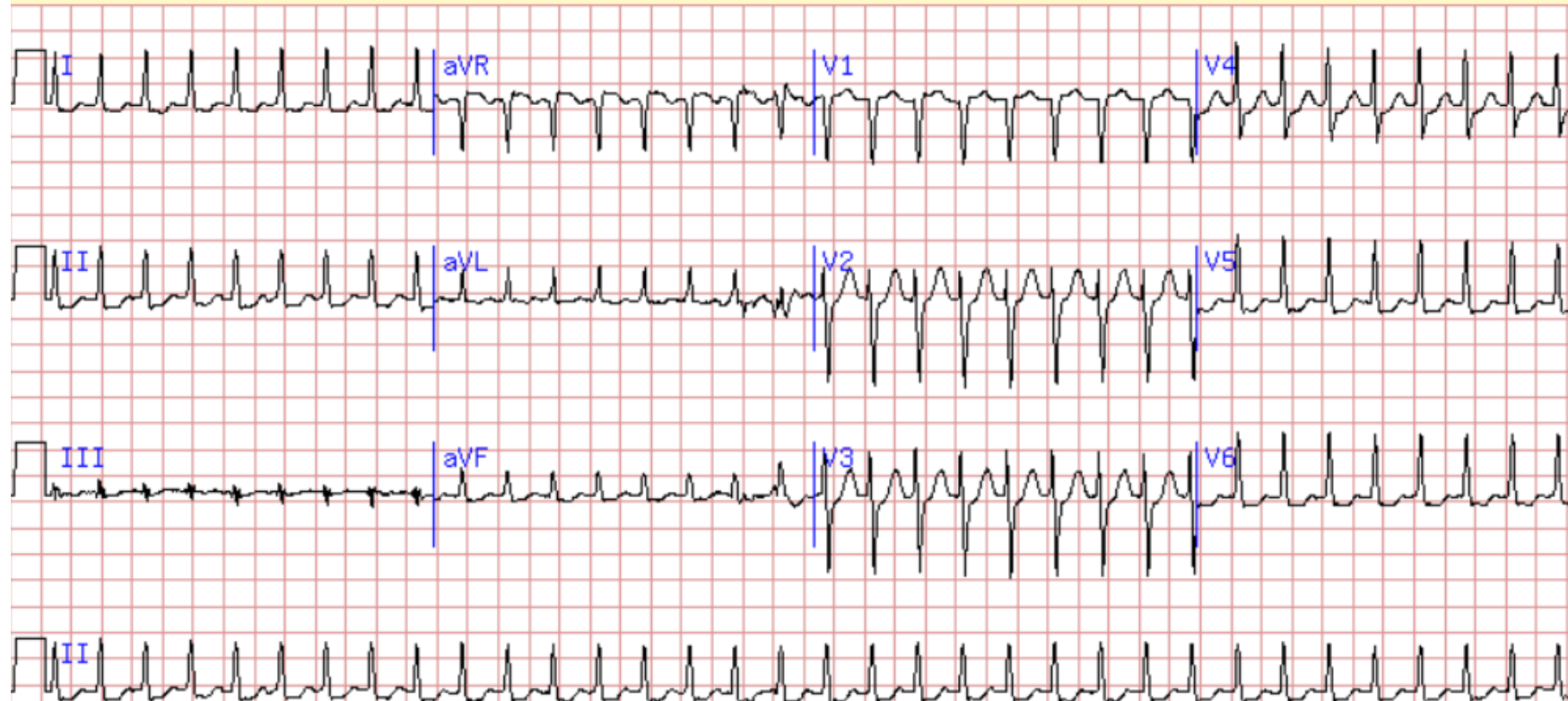
- a) Sinus tachycardia
- b) Atrial flutter with 2:1 conduction
- c) Paroxysmal supraventricular tachycardia (PSVT), probably AV nodal reentrant tachycardia (AVNRT)
- d) Atrial fibrillation
- e) Multifocal atrial tachycardia (MAT).

**Your Answer:**

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**Question:**

60 year old woman with palpitations and rapid pulse at rest. The ECG shows which one of the following arrhythmias? \* \*

*Difficulty rating*

- a) Sinus tachycardia
- b) Atrial flutter with 2:1 conduction
- c) **Paroxysmal supraventricular tachycardia (PSVT), probably AV nodal reentrant tachycardia (AVNRT)**
- d) Atrial fibrillation
- e) Multifocal atrial tachycardia (MAT).

The ECG shows a very regular narrow complex tachycardia, ventricular rate of 200 bpm. The rate is too fast for resting sinus tachycardia in a patient of this age group. The rhythm is too regular for atrial fibrillation or MAT. The rate is not compatible with atrial flutter with 2:1 conduction since the atrial rate would have to be 400 cycles/min, beyond the atrial depolarization of that rhythm. By exclusion the rhythm is paroxysmal supraventricular tachycardia. No definite P waves are evident and the mechanism is likely AV nodal reentry (with P waves "hidden" in the QRS or perhaps partly visible at the very end of QRS with a superior axis). The ST depressions are non-diagnostic in this context.

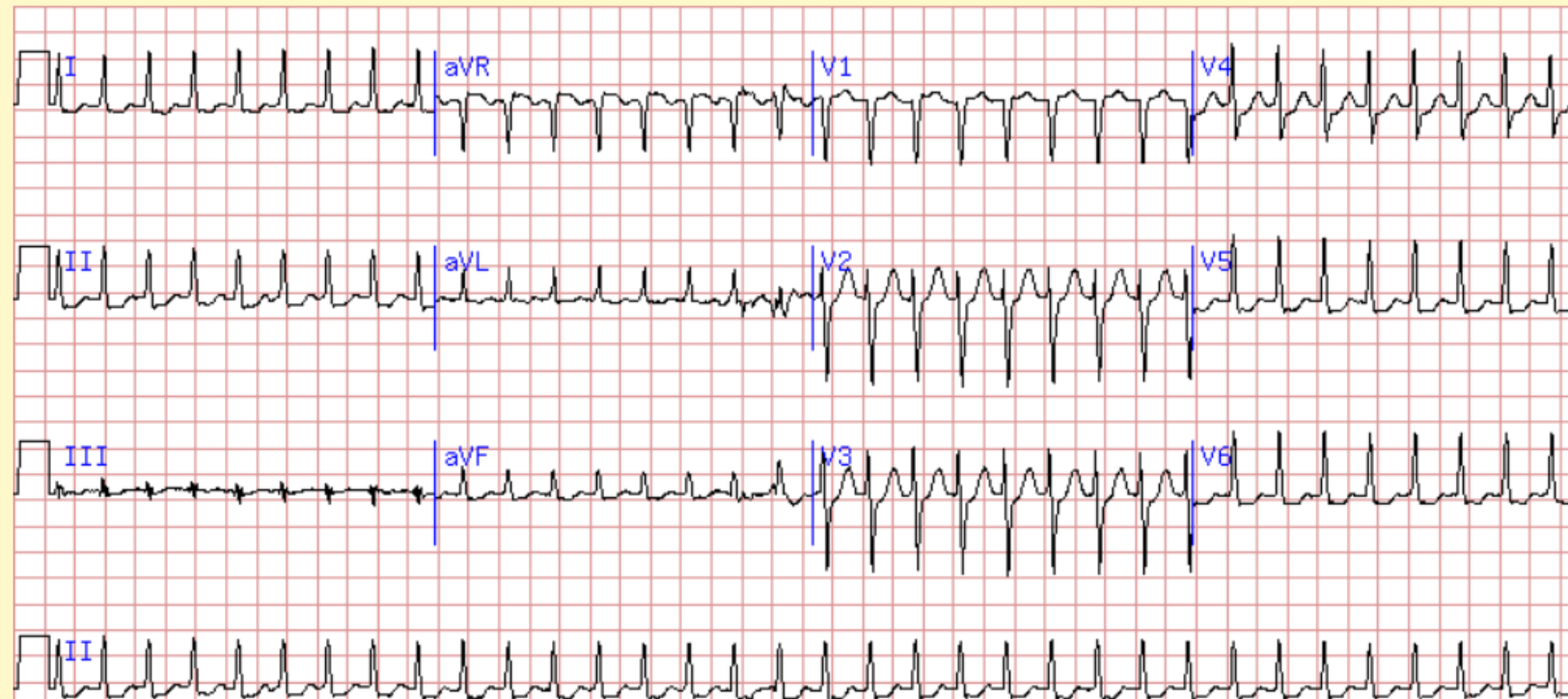
**Answer:**

For a superb tutorial and simulation of AVNRT and other supraventricular tachycardias, see:  
<http://www.blaufuss.org/SVT/index2.html>

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**Question:** What is this rhythm? \*\*\* *Difficulty rating*

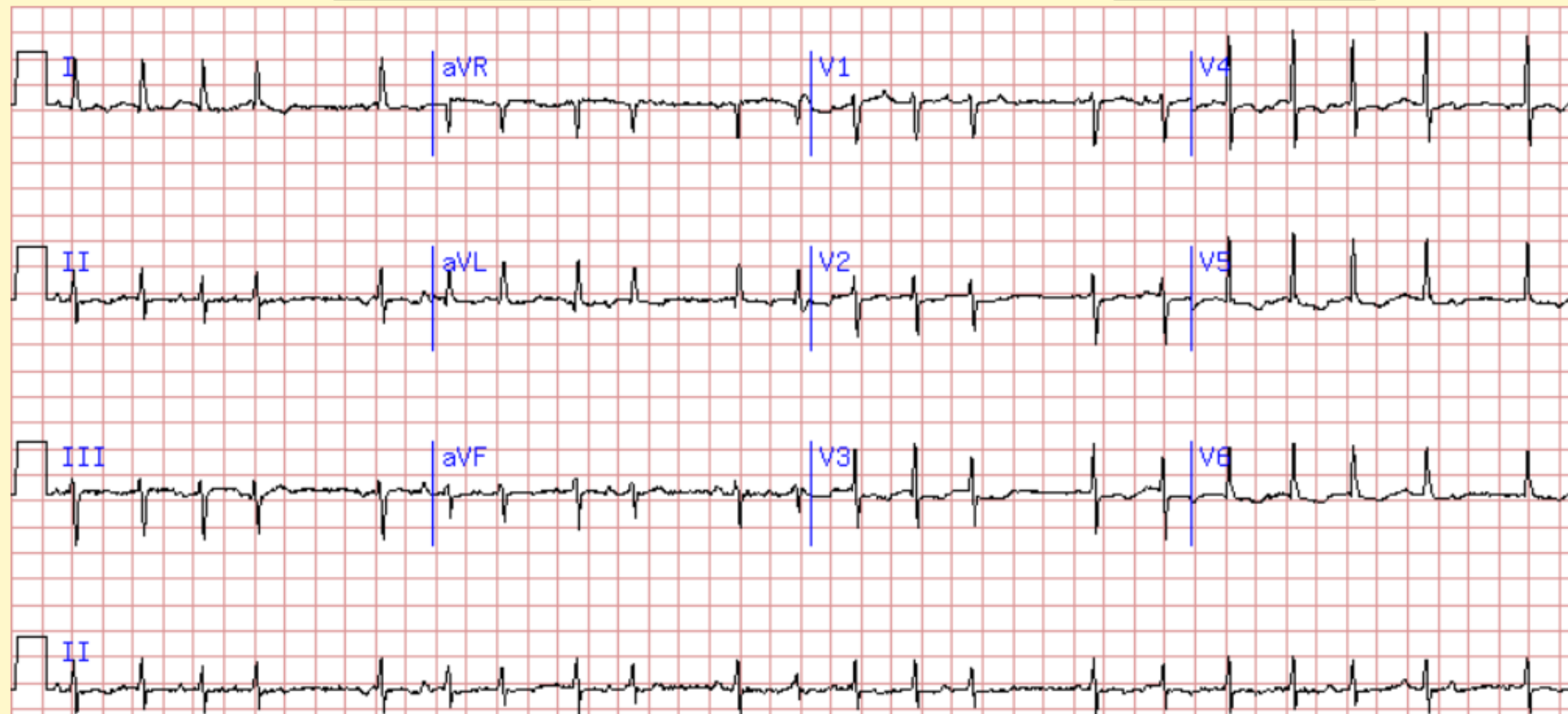
- a) Atrial flutter with variable block
- b) Atrial fibrillation
- c) Wandering atrial pacemaker (WAP)
- d) Atrio-ventricular reentrant tachycardia (AVRT)
- e) Multifocal atrial tachycardia (MAT)

**Your Answer:**

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**Question:** What is this rhythm? \*\*\* *Difficulty rating*

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- b) Atrial fibrillation
- c) Wandering atrial pacemaker (WAP)
- d) Atrio-ventricular reentrant tachycardia (AVRT)
- e) **Multifocal atrial tachycardia (MAT)**

e) Three or more consecutive ectopic (non-sinus) P waves are present at a rapid rate. The patient had an exacerbation of severe chronic obstructive pulmonary disease (COPD), a common substrate in patients with multifocal atrial tachycardia (MAT). In contrast, wandering atrial pacemaker (WAP) is a slower rhythm, usually with more gradual change in P waves.

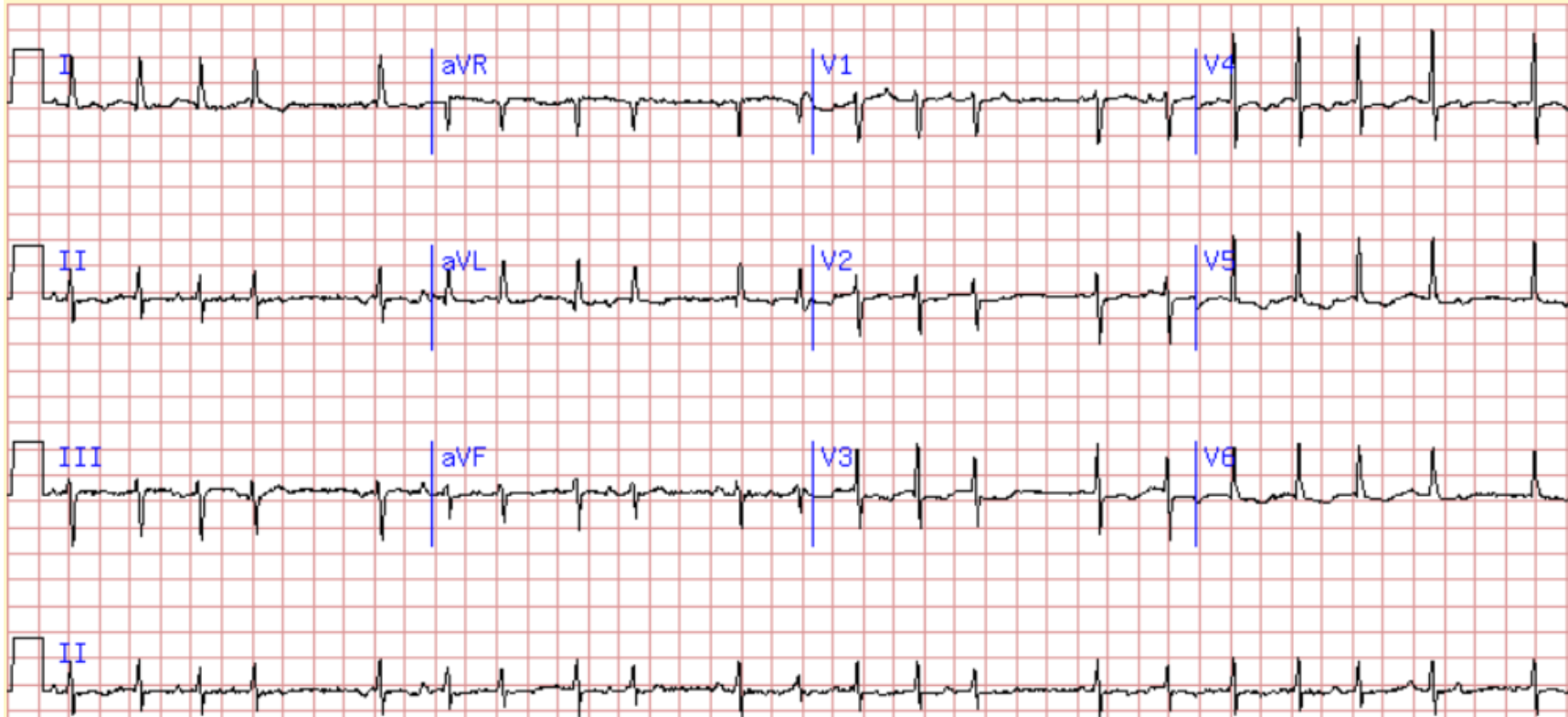
**Answer:**

(Note that some of the ectopic P waves are non-conducted.)

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Question:

Challenging ECG from a middle-age man who shortly thereafter developed atrial fibrillation, while taking COPD medications. Which ONE of the following is most likely? \* \* \* \* *Difficulty rating*

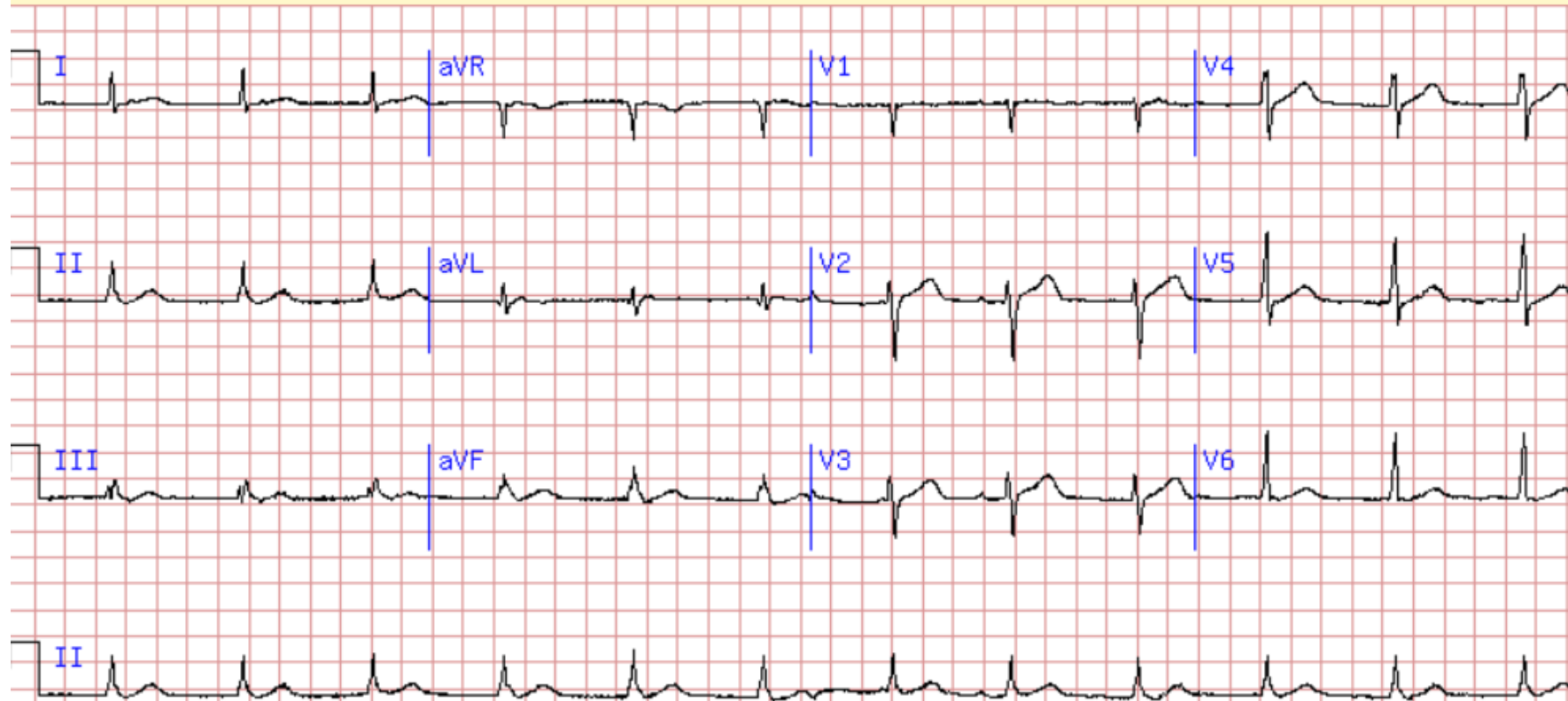
- a) Sinus rhythm with complete AV heart block
- b) Sinus rhythm with WPW pre-excitation
- c) Idioventricular escape rhythm
- d) Accelerated junctional rhythm with occasional sinus beats
- e) Sinus rhythm with 2:1 SA exit block

Your Answer:

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The ECG shows a narrow (normal QRS duration) rhythm at a rate of about 70/min. Most of the beats (e.g., 1-5) are junctional in origin, with retrograde P waves (negative in lead II), apparent just after the QRS. In the 6th beat there is more retrograde AV delay, so the P wave appears at the end of the T wave (longer R-P interval). Following that beat, there is an upright P wave in lead II, partly merged with the QRS, most likely due to sinus rhythm with AV dissociation. The next beat is sinus in origin, followed by the resumption of the accelerated junctional rhythm.

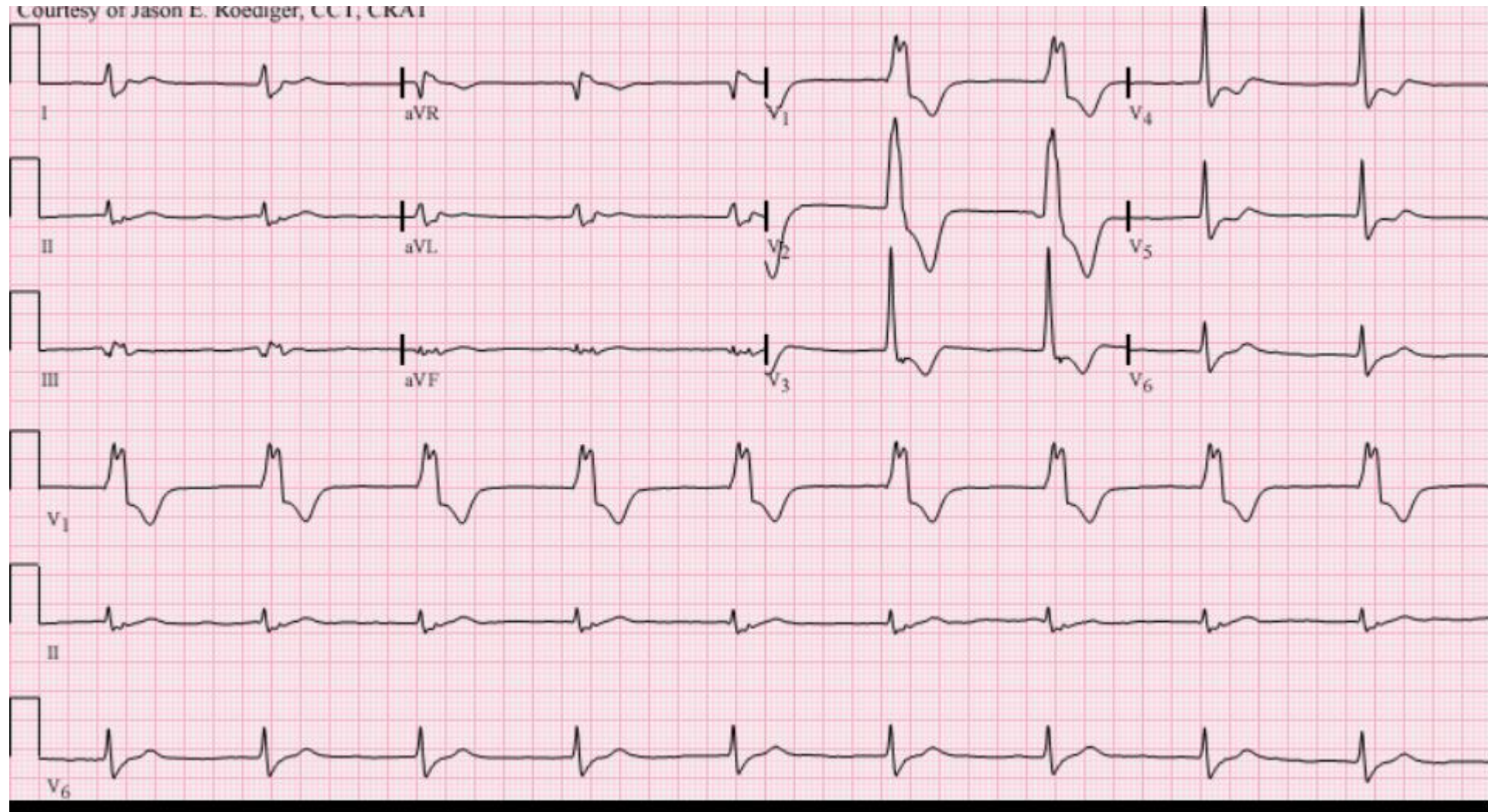
**Answer:**

The term “accelerated” is applied here to contrast this type of junctional rhythm with classical junctional escape rhythms in which the rate is usually 60/min or less. Accelerated junctional rhythms may be seen in a variety of contexts. Usually they do not cause hemodynamic compromise, although right atrial contraction may occur against a closed tricuspid valve, causing cannon A waves, visible on exam of the neck. Digitalis toxicity is one of the most clinically important causes because more severe arrhythmias may ensue. However, the absence of digitalis effect (shortening of the QT interval with scooping of the ST-T) makes this unlikely. In this case, the rhythm was probably related to the sympathomimetic drugs the patient was taking for chronic obstructive pulmonary disease (COPD). Other reported contexts for accelerated junctional rhythms include recent cardiac surgery, hyperkalemia, acute myocardial infarction, and following AV node ablation procedures. The rhythm may also occur transiently in healthy individuals.

From an electrophysiologic viewpoint, these narrow complex rhythms originate above the bifurcation of the bundle of His, either in the His bundle itself, or in the vicinity of the AV node. They have been ascribed to increased automaticity of pacemaker tissue or to triggered activity (i.e., afterdepolarizations). Finally, the term “non-paroxysmal junctional tachycardia” is sometimes used to describe accelerated junctional rhythms (rates 70-130/min). However, some authors balk at using the term “tachycardia” for rhythms with rates below 100/min.

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Courtesy of Jason E. Koediger, CCT, CRAI



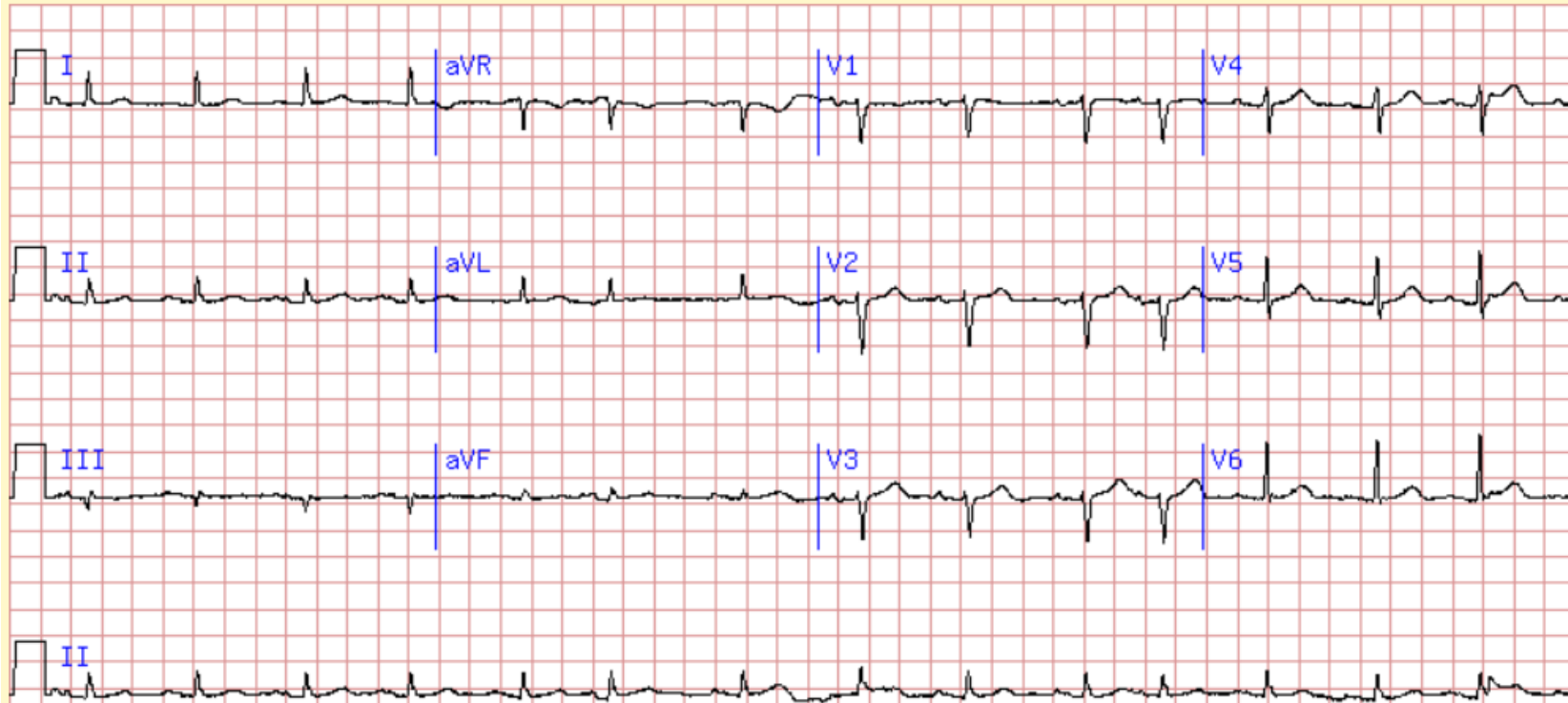
**Question:**

ECG from an elderly adult man. What does the rhythm strip show? (Note: baseline artifact is present possibly due to movement.) \*\*\* *Difficulty rating*

- a) Physiologic (respiratory) sinus arrhythmia
- b) Sinus rhythm with intermittent AV Wenckebach
- c) Sinus rhythm with intermittent SA Wenckebach
- d) Wandering atrial pacemaker (WAP)
- e) **Sinus rhythm with premature atrial complexes (PACs)**

**Answer:**

The ECG shows underlying sinus rhythm with PACs. There is a normal QRS axis and normal intervals. Of note, evidence of left atrial abnormality is present. (Biphasic P wave in lead V1 with broad, terminal negative component and broad notched P waves in other leads.) There is also nonspecific slow precordial r wave progression (V1-V4) and non-diagnostic inferior Q waves. The patient had a history of atrial flutter/fibrillation in the context of advanced age, systemic hypertension, and type 2 diabetes mellitus. Echocardiographic imaging had shown left atrial dilation with preserved left ventricular systolic function. The P wave features are best seen in magnified views.

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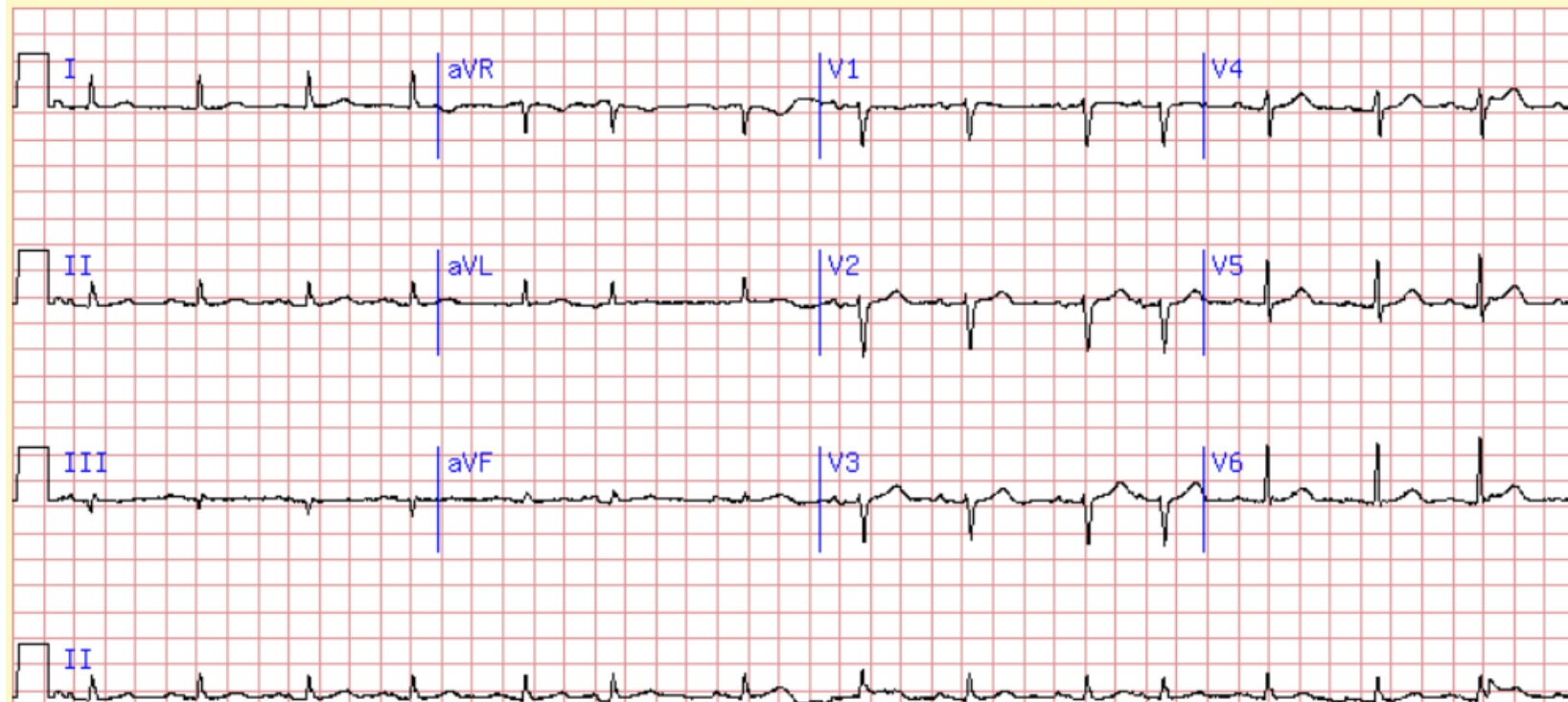
**Answer:**

The ECG shows underlying sinus rhythm with PACs. There is a normal QRS axis and normal intervals. Of note, evidence of left atrial abnormality is present. (Biphasic P wave in lead V1 with broad, terminal negative component and broad notched P waves in other leads.) There is also nonspecific slow precordial r wave progression (V1-V4) and non-diagnostic inferior Q waves. The patient had a history of atrial flutter/fibrillation in the context of advanced age, systemic hypertension, and type 2 diabetes mellitus. Echocardiographic imaging had shown left atrial dilation with preserved left ventricular systolic function. The P wave features are best seen in magnified views.

[Hide Answer](#)

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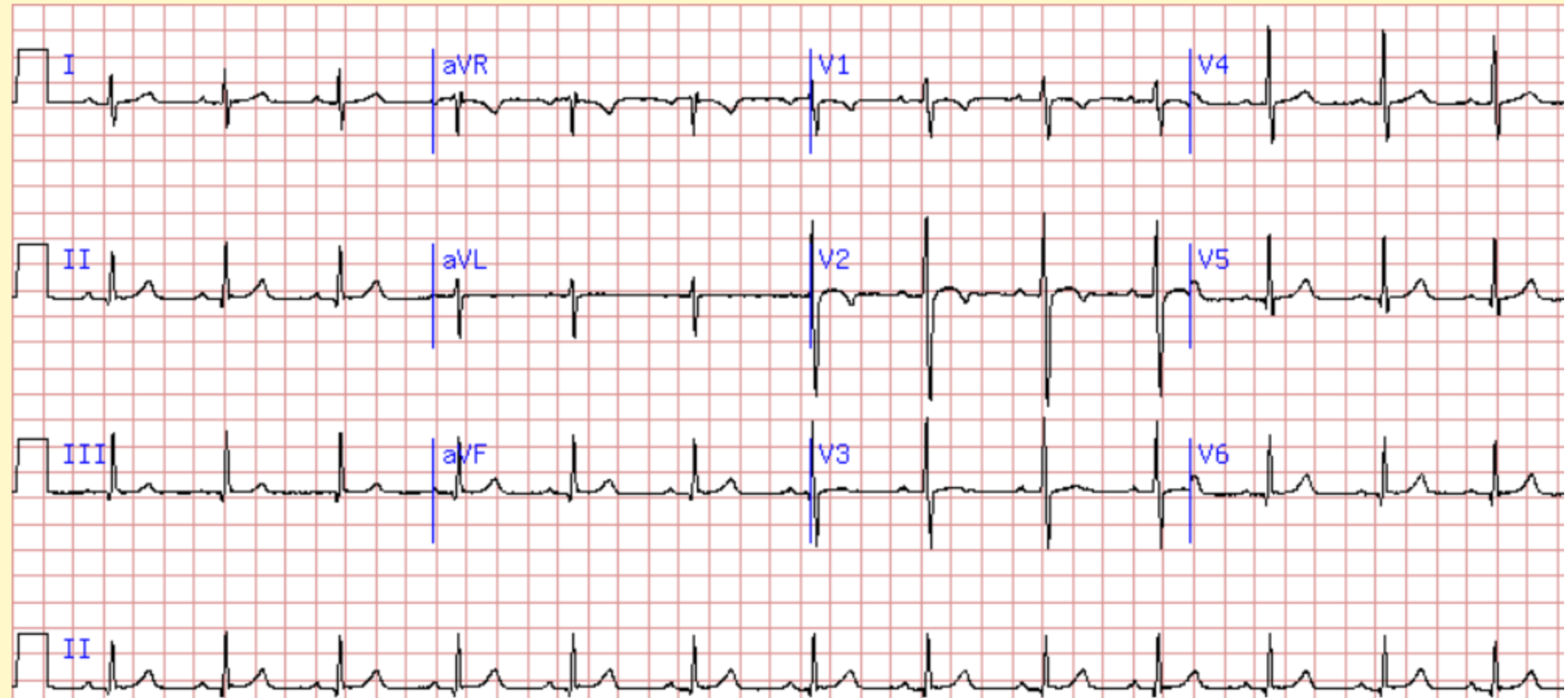
**Question:** What is the first question to ask? \*\*\* *Difficulty rating*

**Answer:** What is the patient's age? This is a normal ECG in an 11-year-old male. The T-wave inversions in V1-V3 are a normal finding in children, and may persist into adulthood. The vertical QRS axis (about +90 degrees) and early precordial transition are also physiologic findings.

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**Question:** 20-year-old woman is found unresponsive. What is the most likely cause? \* \* \* *Difficulty rating*

In addition to prominent sinus tachycardia, there is an intraventricular conduction delay (IVCD) with a rightward or indeterminate QRS axis. The QT is somewhat prolonged for the rate. The triad of sinus tachycardia, a wide QRS and a long Q-T in an obtunded patient should immediately suggest tricyclic antidepressant (TCA) overdose. Of note, the IVCD in these cases is often associated with a terminal S wave (rS) in lead I, and a terminal R wave (qR) in aVR, as present here (see: Crit.Care Med.1997;25:1721).

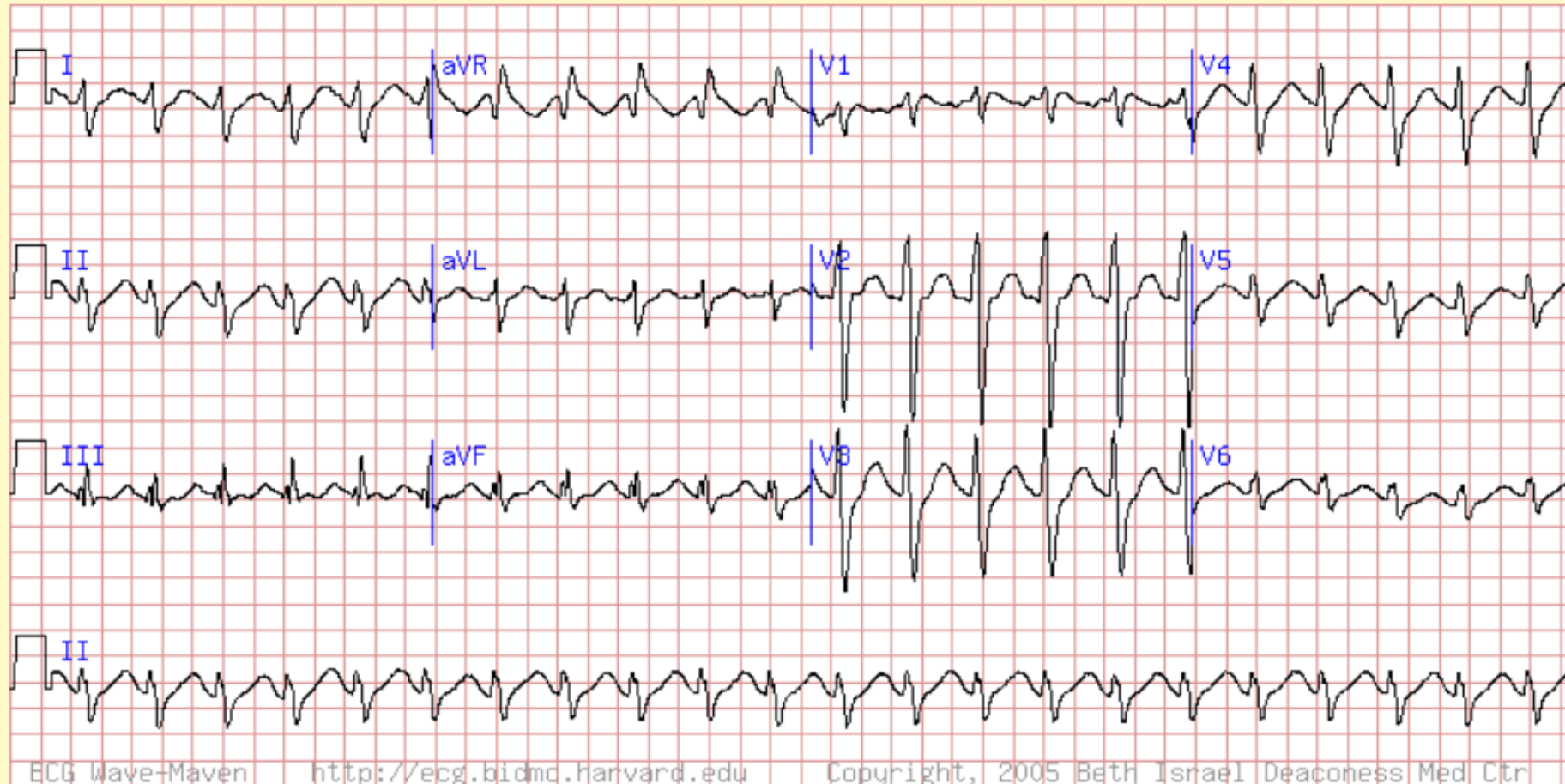
**Answer:**

The P waves are difficult to see (V1, for example) and in some leads (II, aVF) appear to merge with the end of the T wave.

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**Question:** Which clinical syndrome best fits the ECG in this 60-year-old male in the Intensive Care Unit? \*\*\* *Difficulty rating*

- a) Acute anterior myocardial infarction
- b) Primary hyperparathyroidism
- c) Acute pulmonary embolism
- d) Acute renal failure**
- e) Syndrome of inappropriate ADH (SIADH)

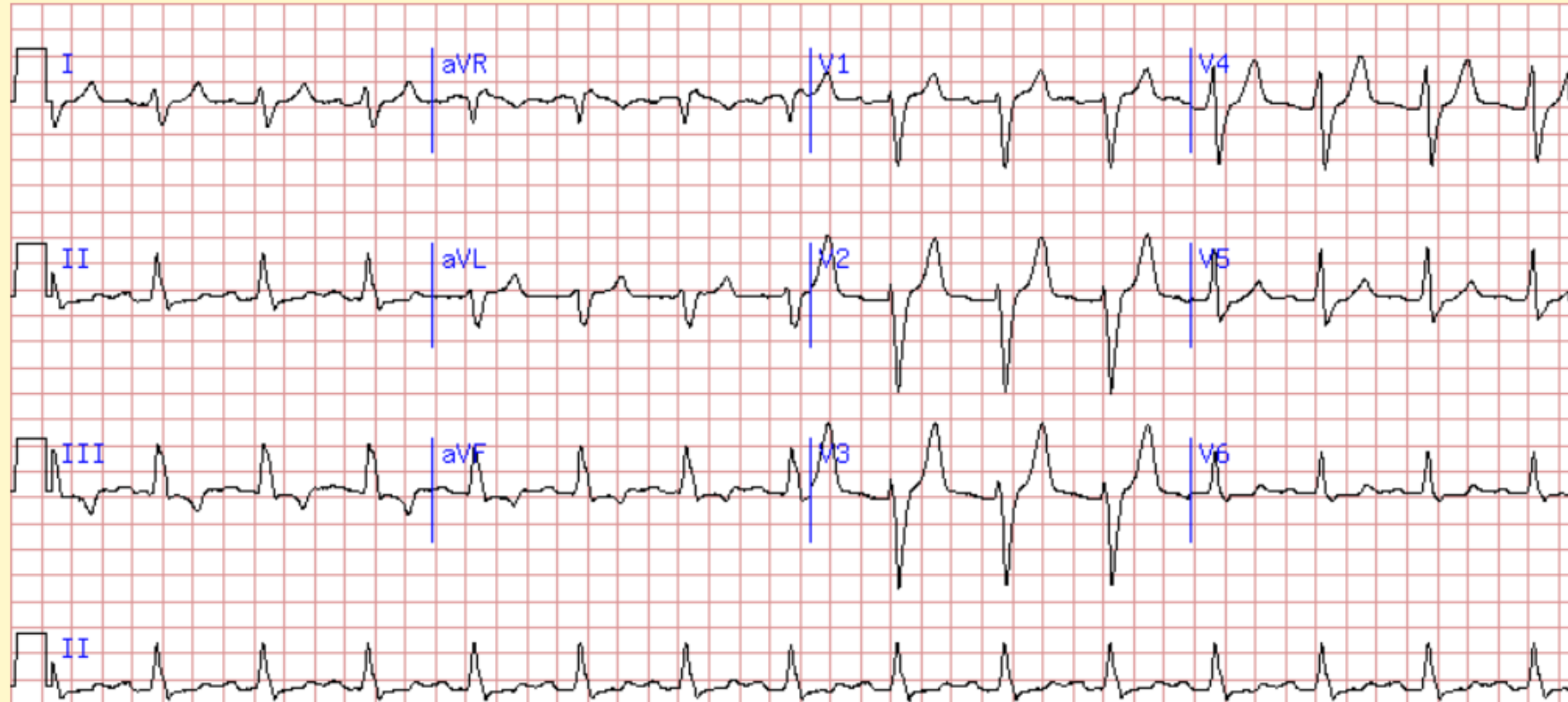
**Answer:**

d) The serum potassium was 8.9 mEq/L. Note the wide QRS with tall ("peaked" or "tented") T waves in V2-V4. The PR interval is prolonged. Left atrial abnormality is also present. (Borderline right axis deviation is present which is non-diagnostic and could be due to incipient left posterior fascicular block associated with hyperkalemia or to other factors such as chronic obstructive pulmonary disease).

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**Question:**

A 71-year-old woman in the Intensive Care Unit with end stage renal disease developed mental status changes and had this ECG. The findings are consistent with all of the following **EXCEPT**? \*\*\*\*\* *Difficulty rating*

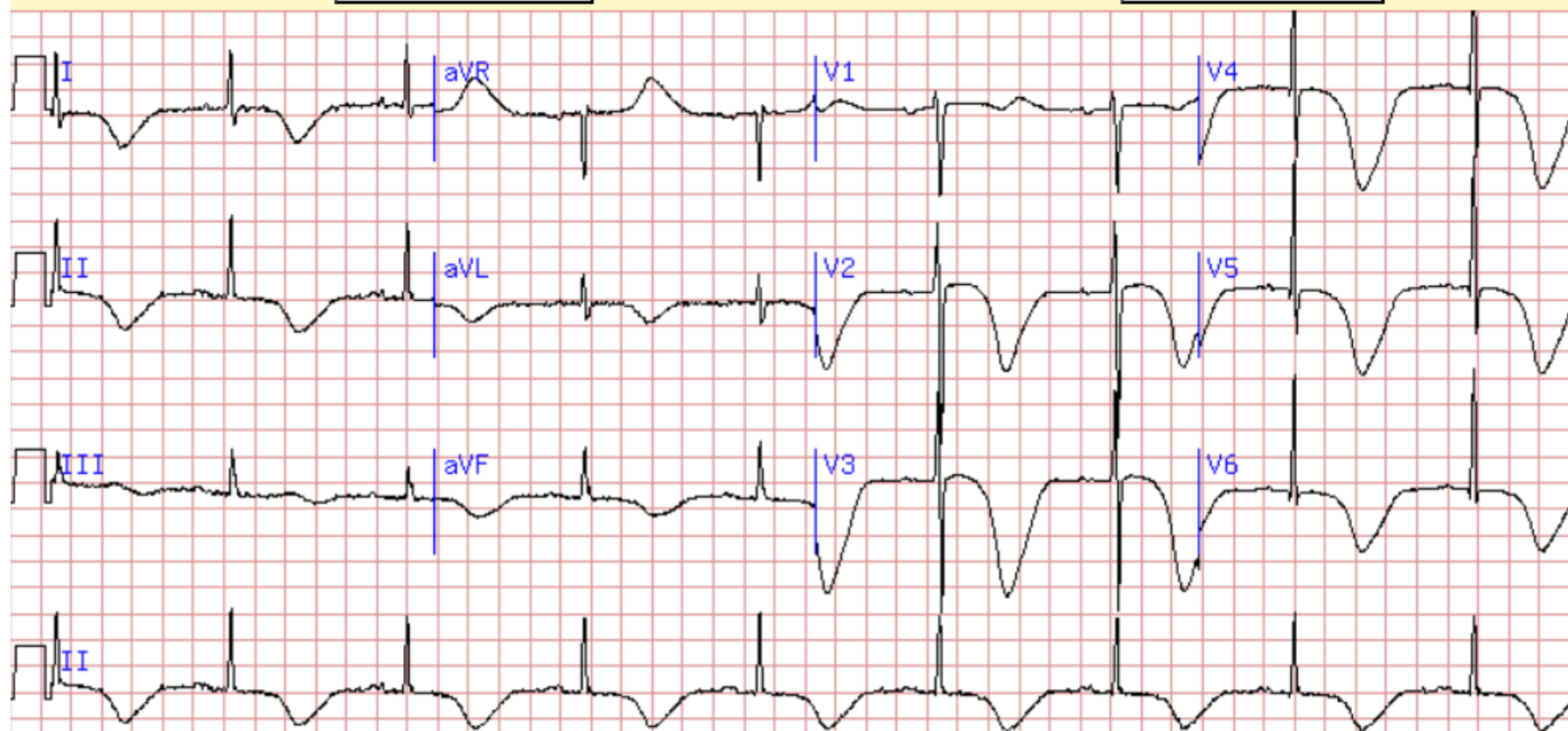
- a) Cerebrovascular accident, especially subarachnoid hemorrhage or other intracranial bleed
- b) Idiopathic global wave inversion syndrome
- c) Atypical myocardial ischemia pattern with left ventricular hypertrophy
- d) Stokes-Adams syncope with underlying left ventricular hypertrophy
- e) Class 1A antiarrhythmic drug toxicity

**Your Answer:**

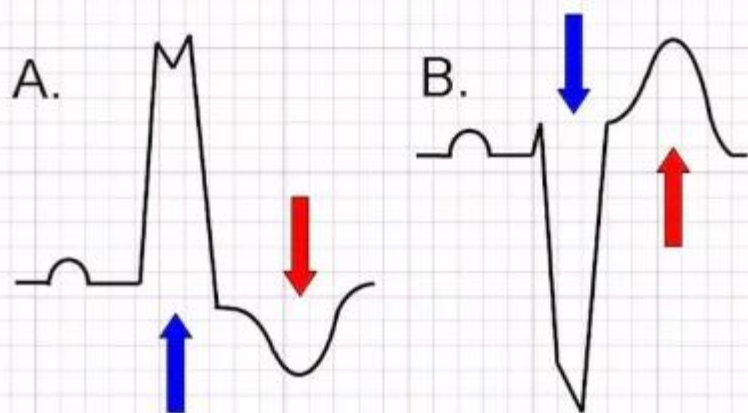
Show Answer

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## Discordant ST-Segments and T-Waves



Normal for LBBB and paced rhythm

Image: ECGMedicalTraining.com

## Sgarbossa's Criteria LBBB / Paced Rhythm

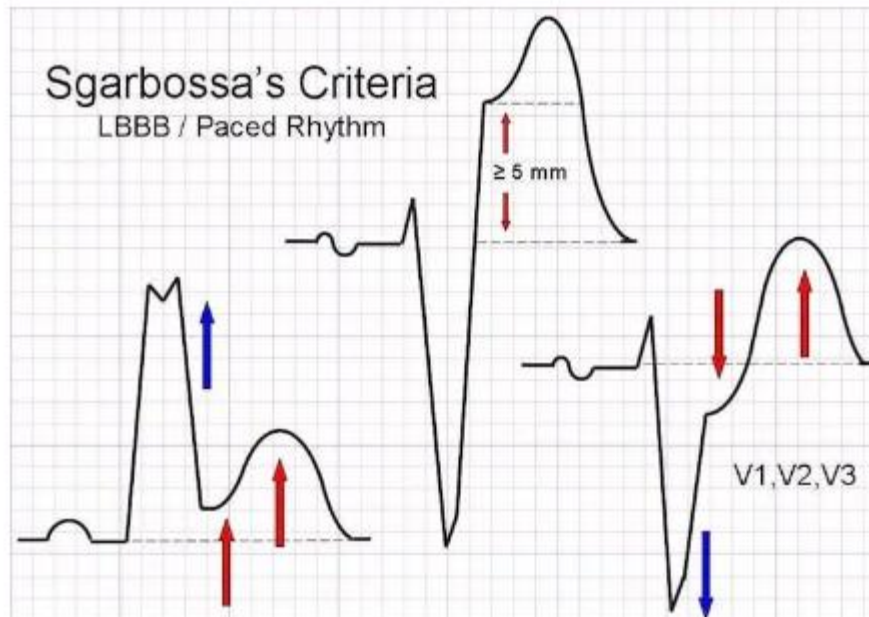


Image: ECGMedicalTraining.com