

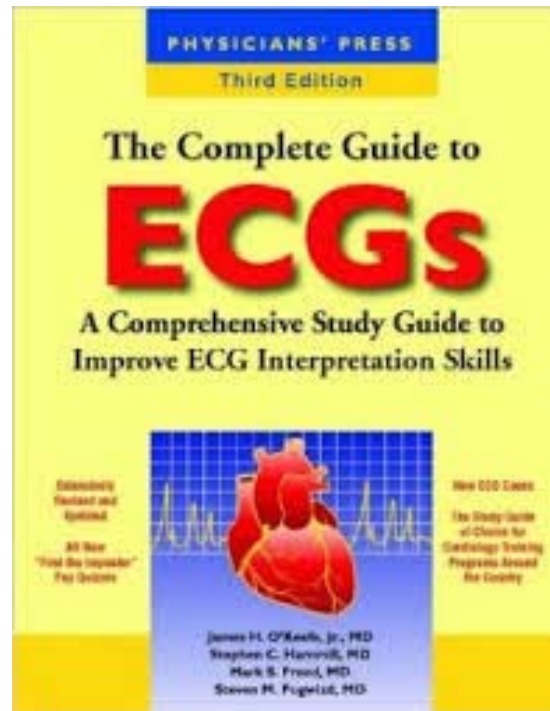
ECG Pattern Recognition

Siddharth Prakash, MD, PhD

Associate Professor

Cardiology and Medical Genetics

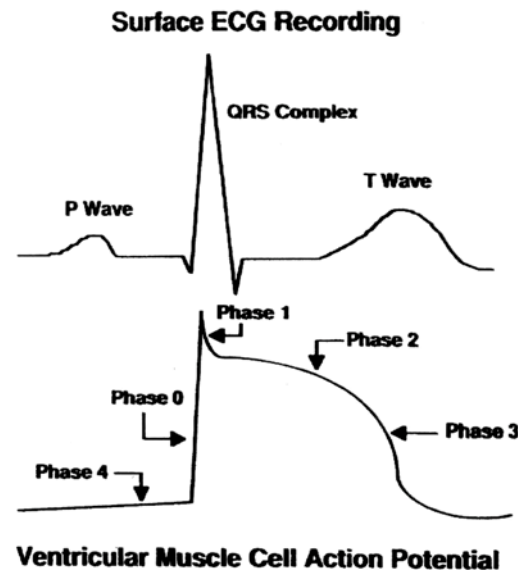
Recommended ECG Book



+ECGpedia

ECG Interpretation: Steps

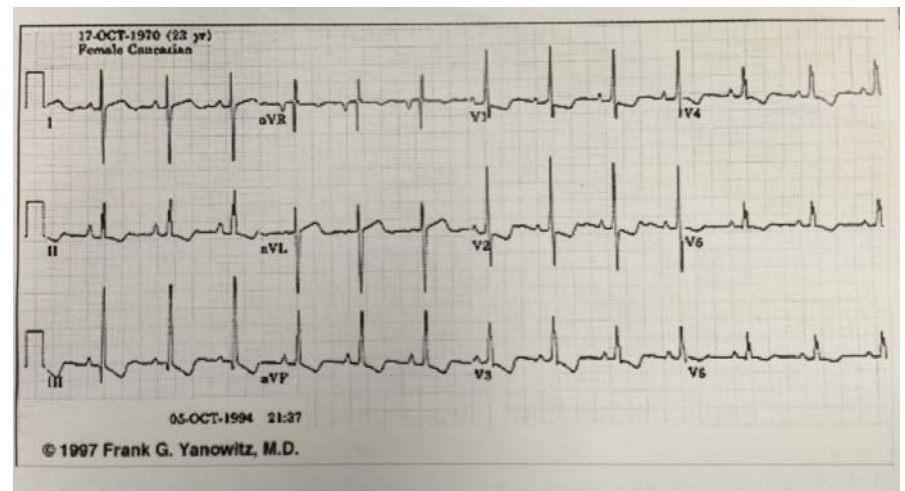
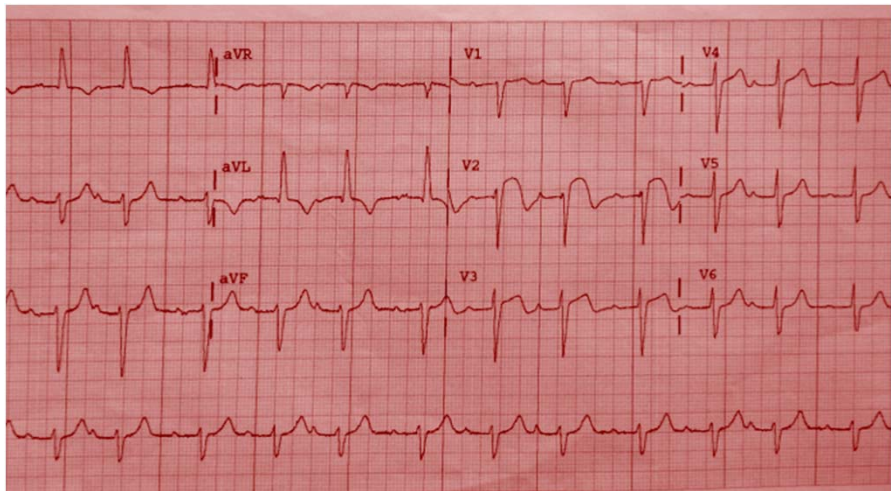
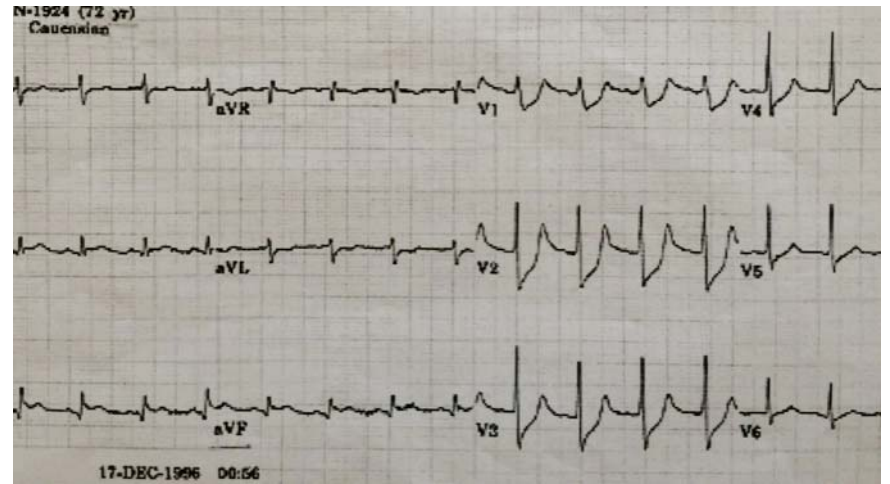
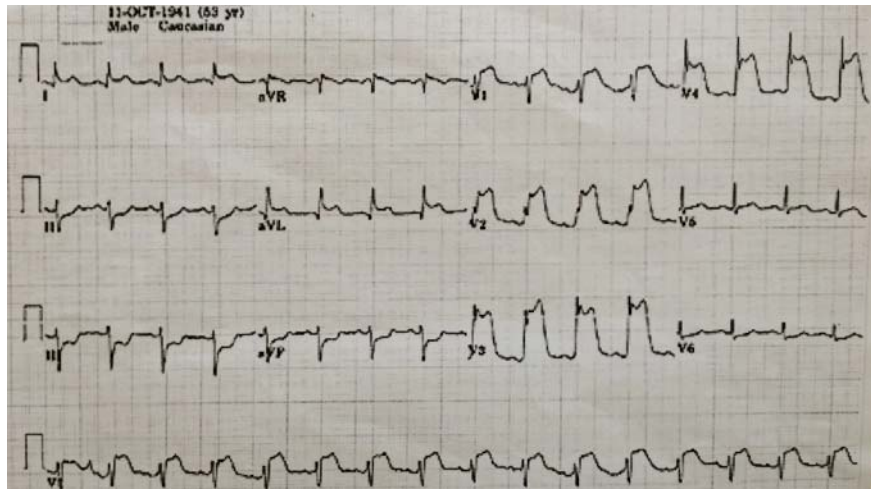
- Identify common ECG pattern
- Underlying electrophysiologic disturbance



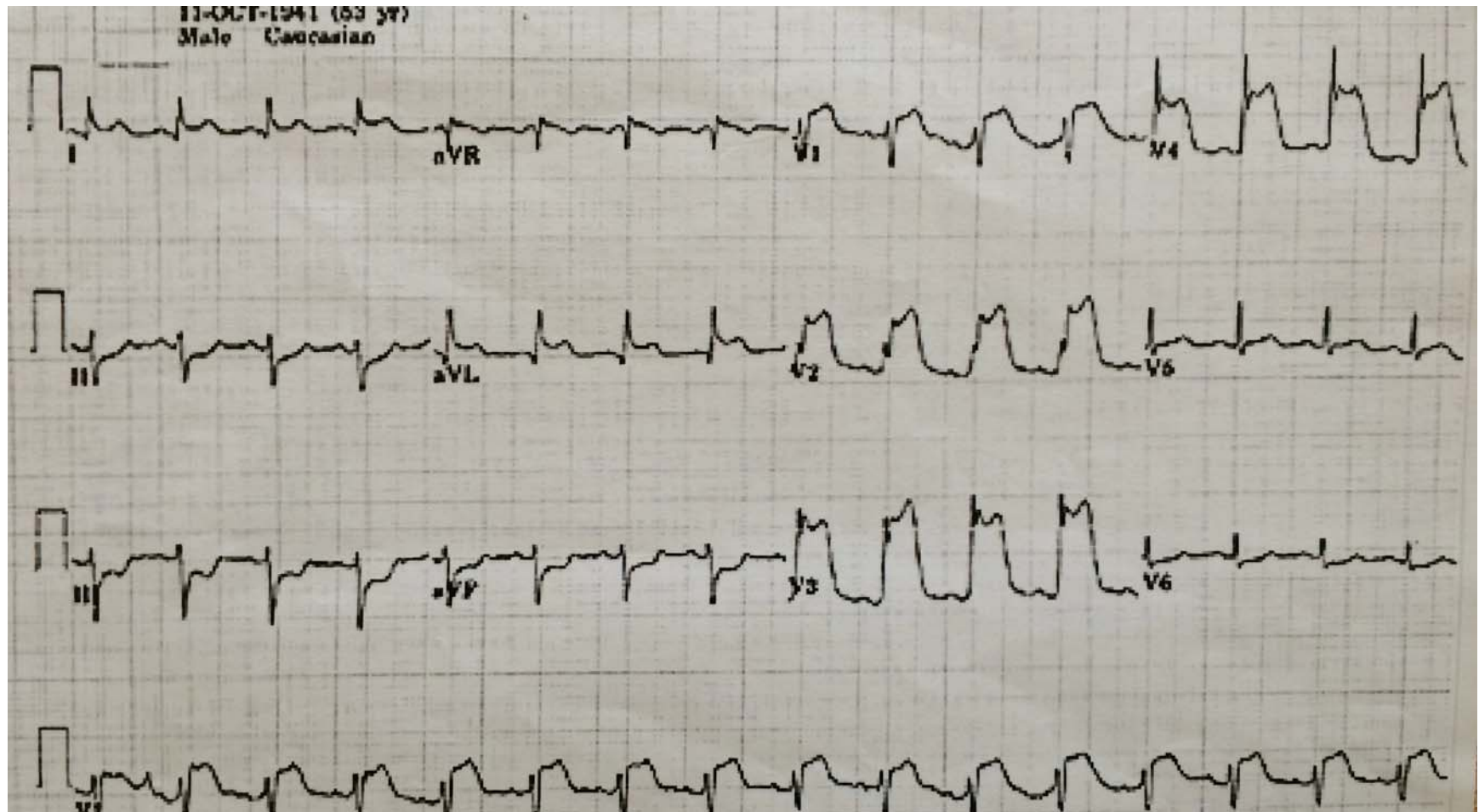
- Pathophysiology
- Differential diagnosis

- Step 1: Rhythm
- Step 2: Rate
- Step 3: Conduction (PQ, QRS, QT)
- Step 4: Heart axis
- Step 5: P wave morphology
- Step 6: QRS morphology
- Step 7: ST morphology

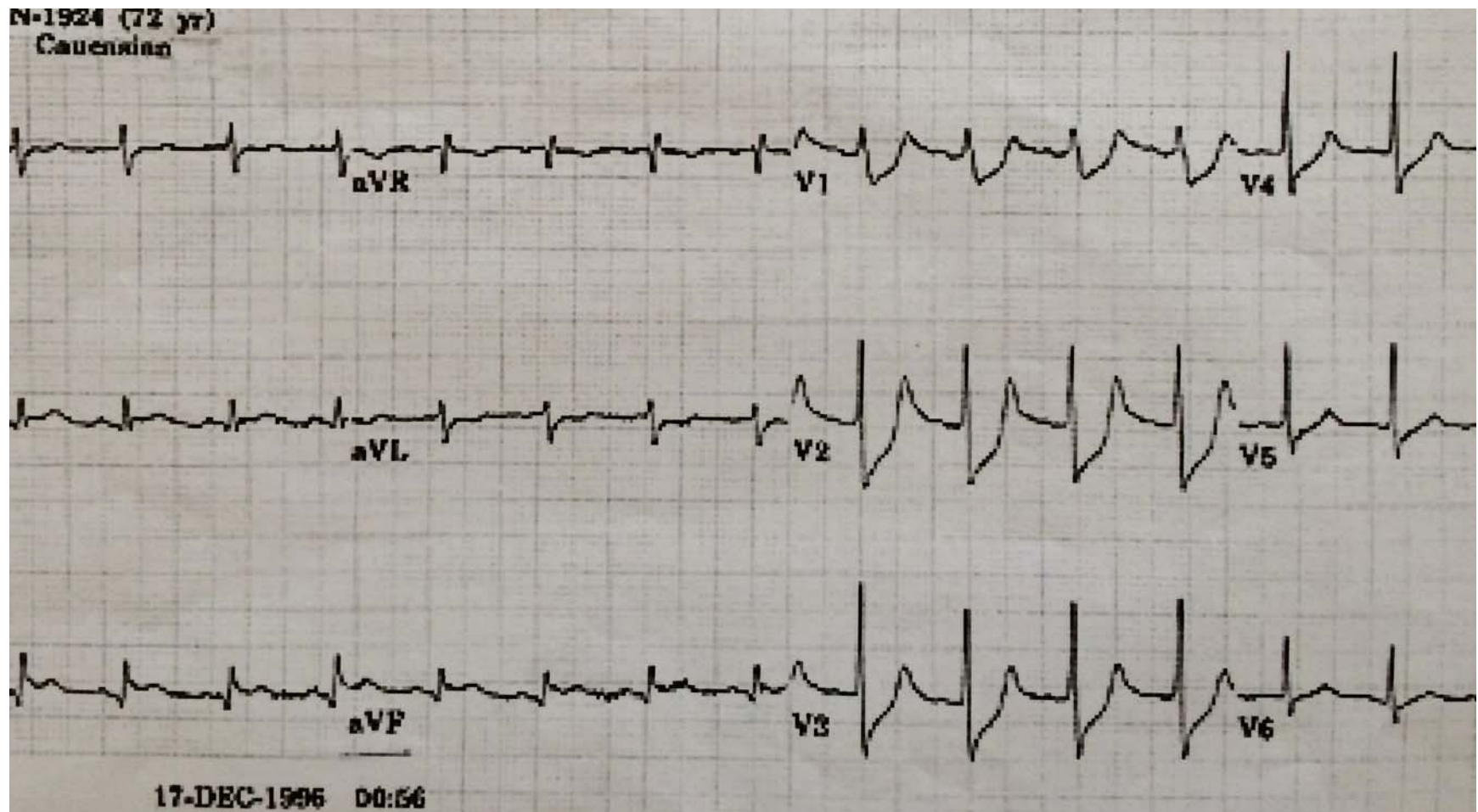
Group 1



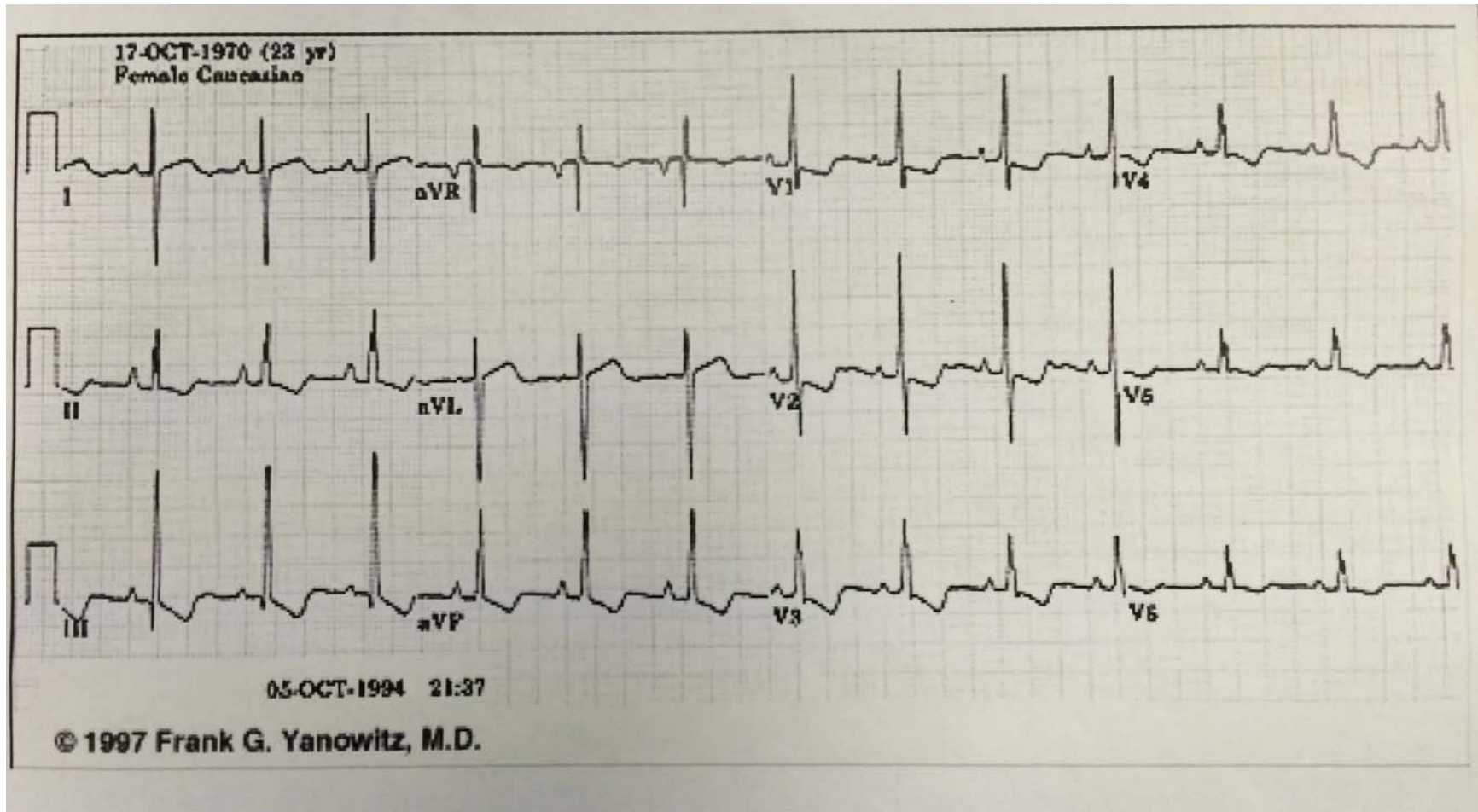
Group 1



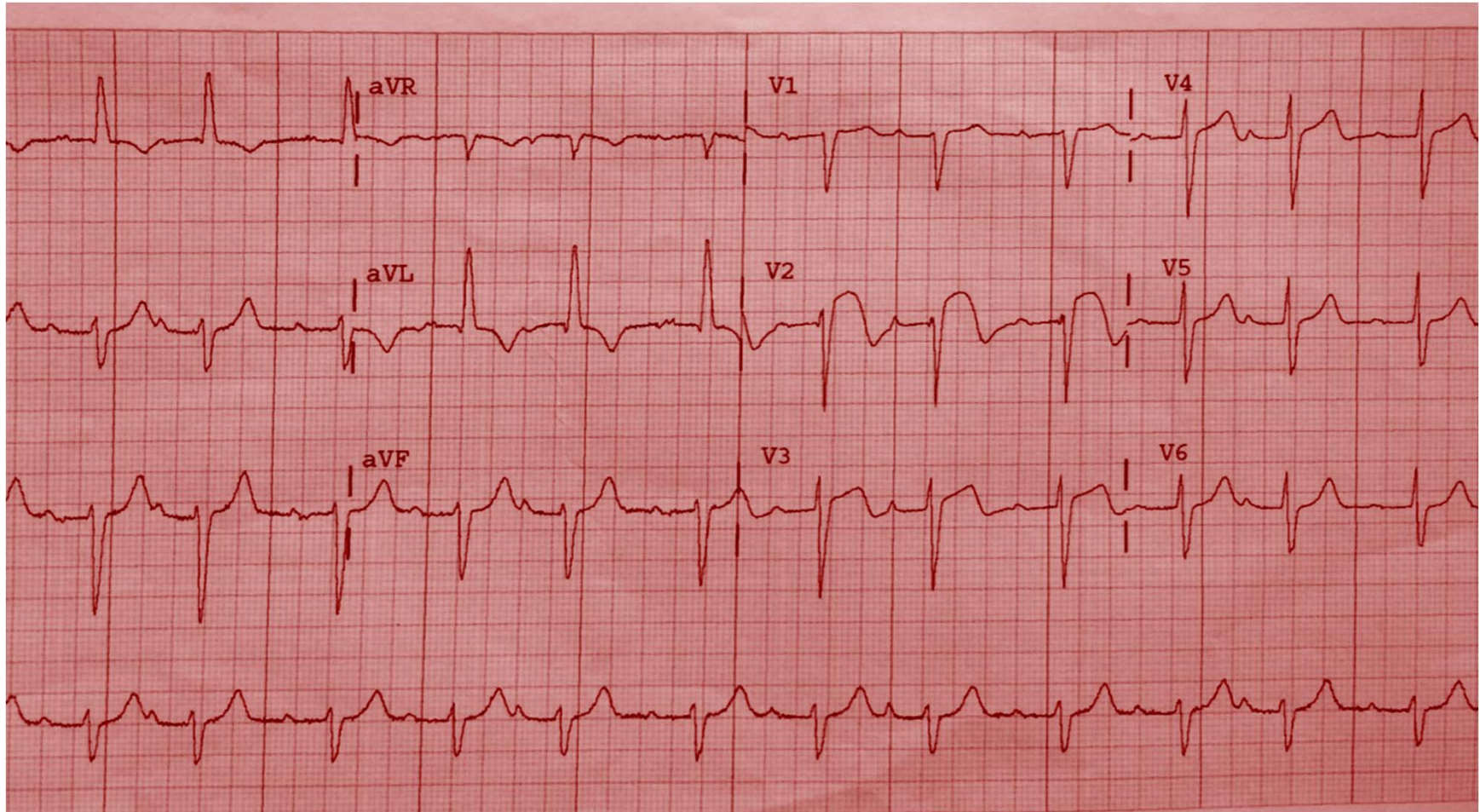
Group 1



Group 1

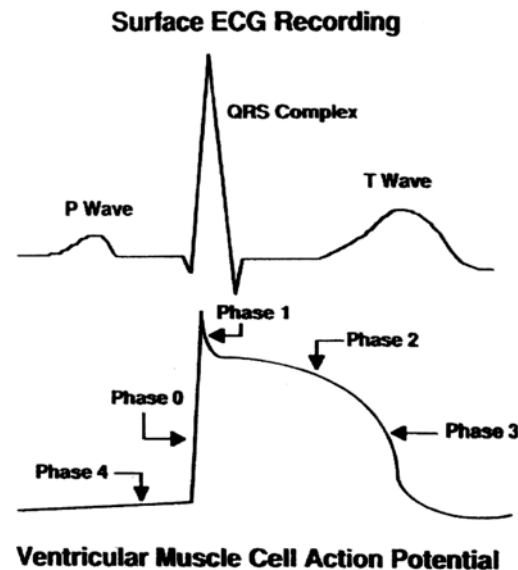


Group 1



ECG Interpretation: Steps

- Identify common ECG pattern
- Underlying electrophysiologic disturbance

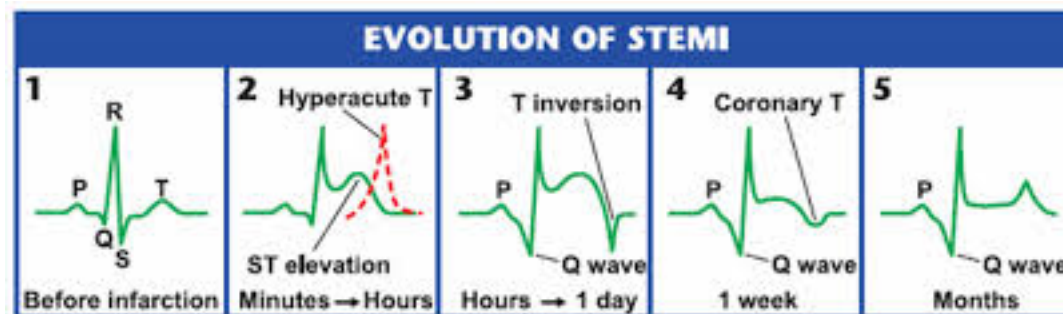
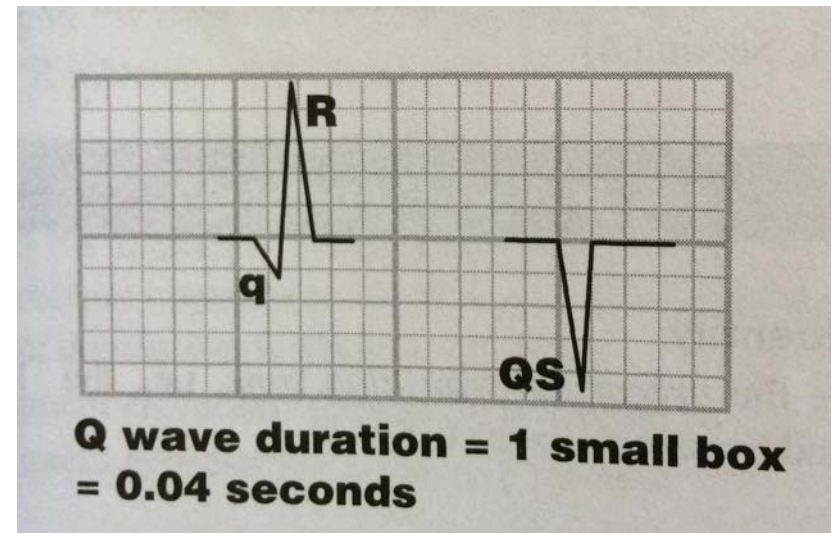
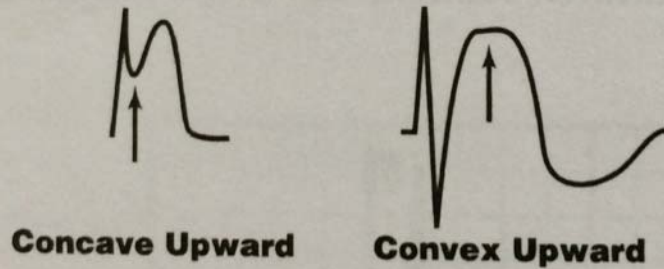


- Pathophysiology
- Differential diagnosis

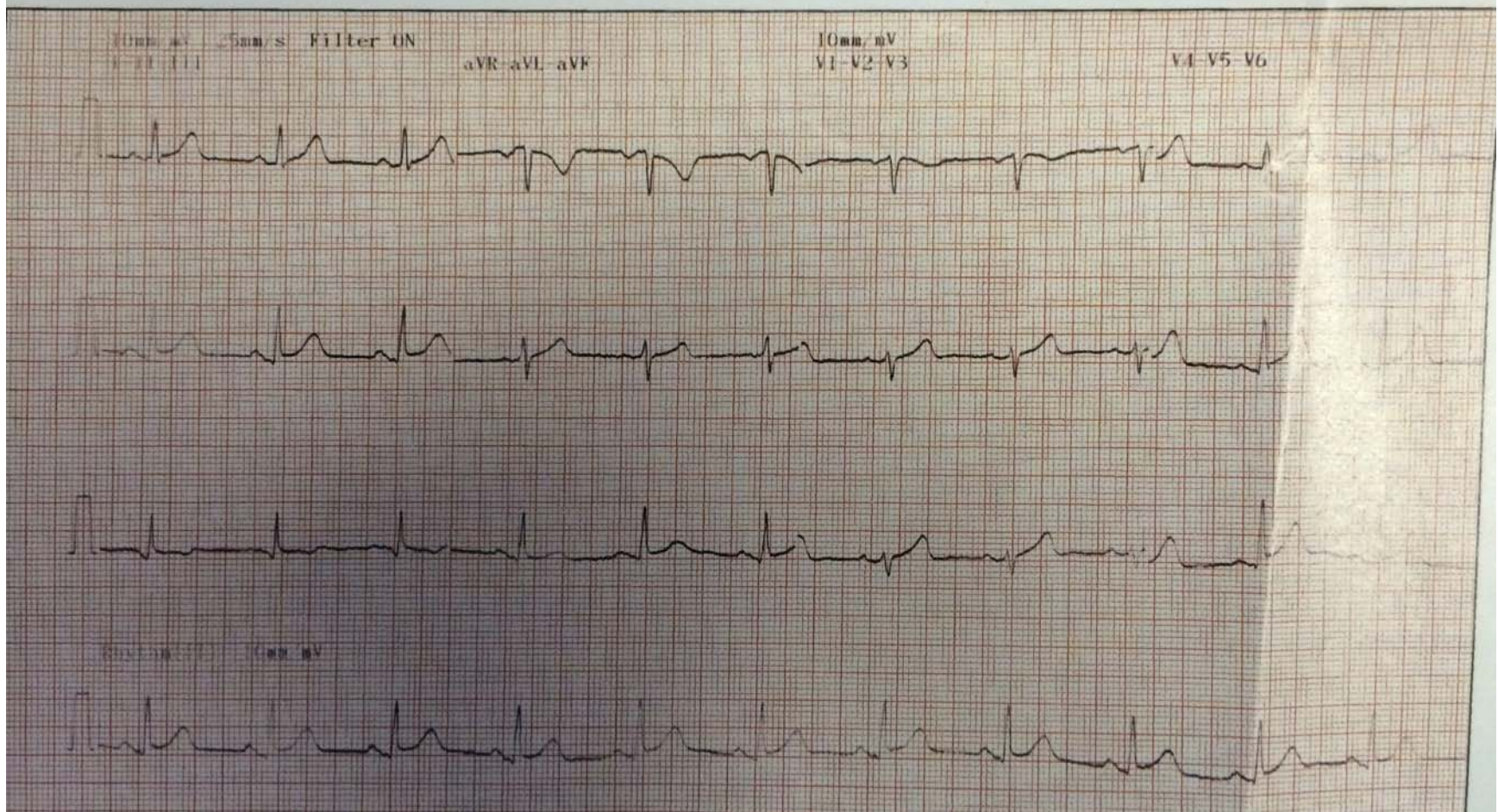
Group 1: STEMIs

- ST segment morphology

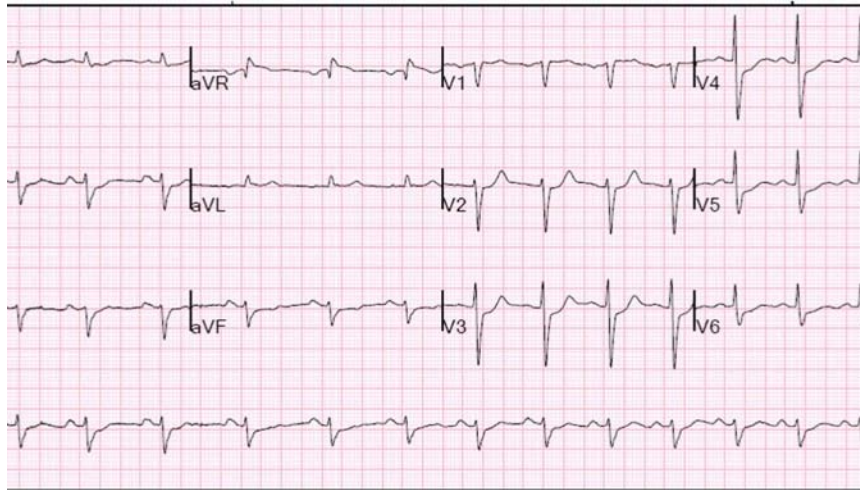
ST ELEVATION:



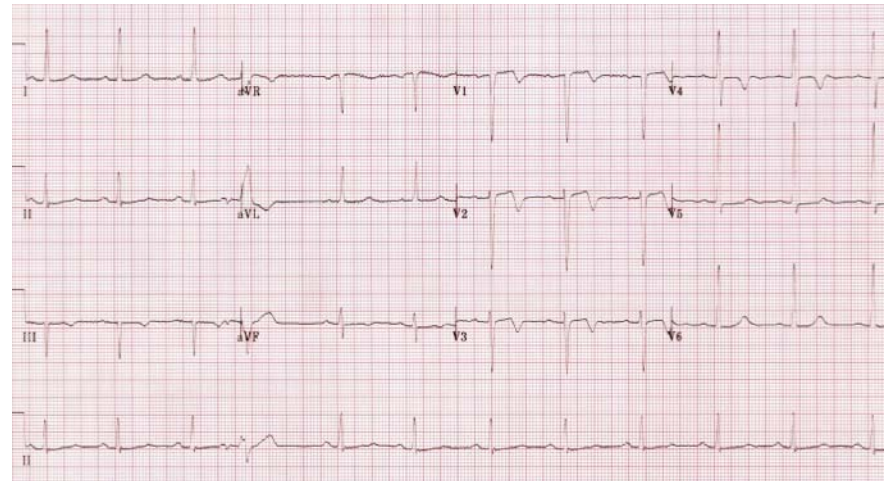
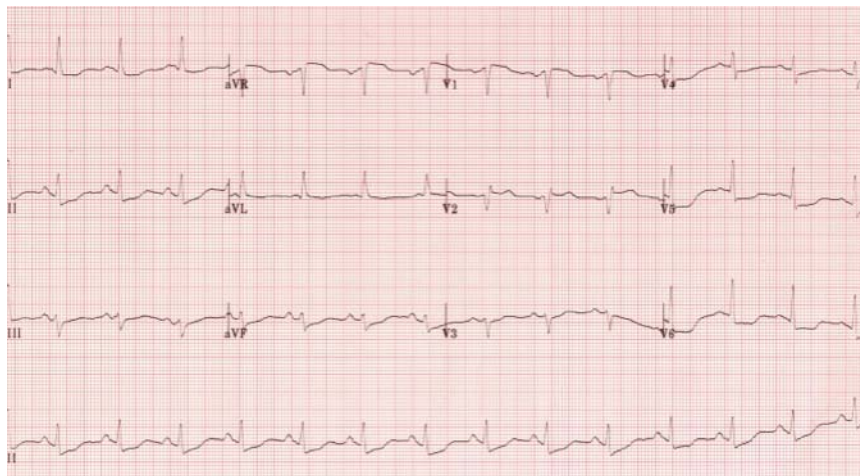
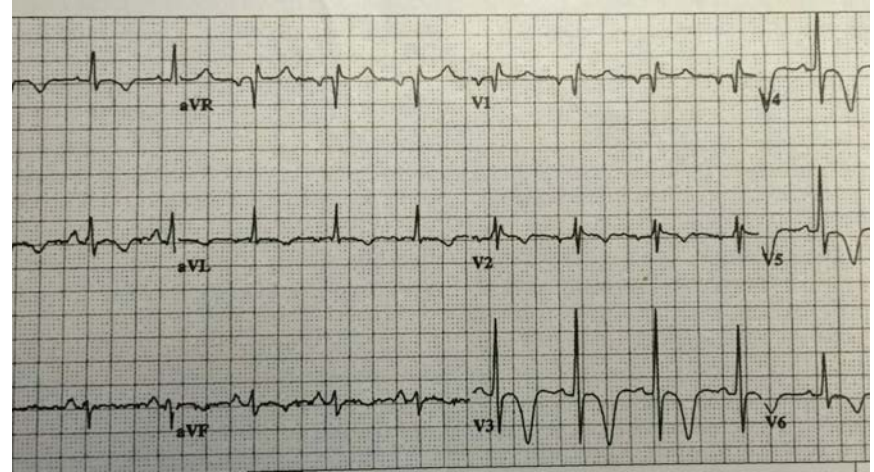
Early Repolarization: Normal Variant



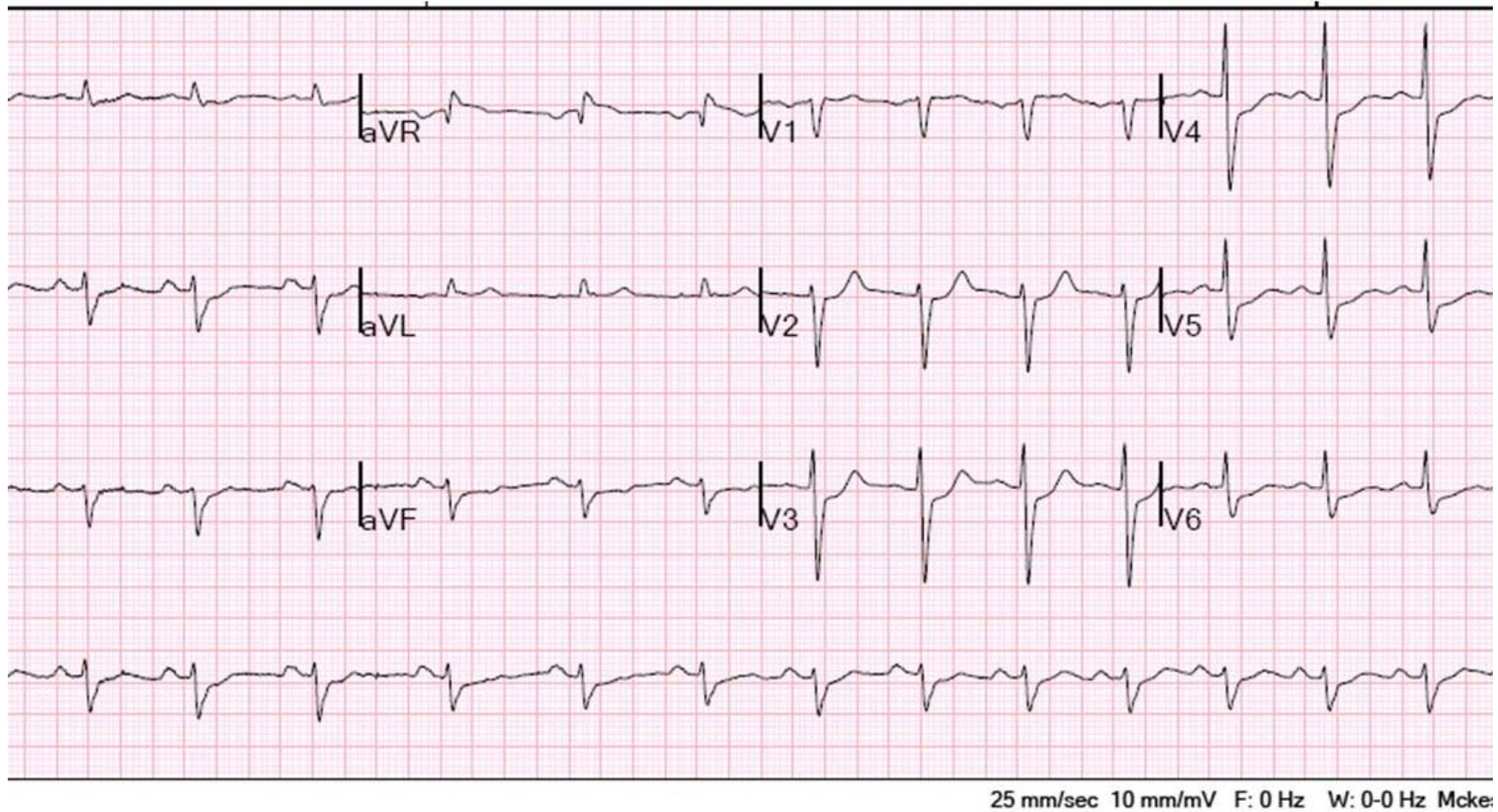
Group 2



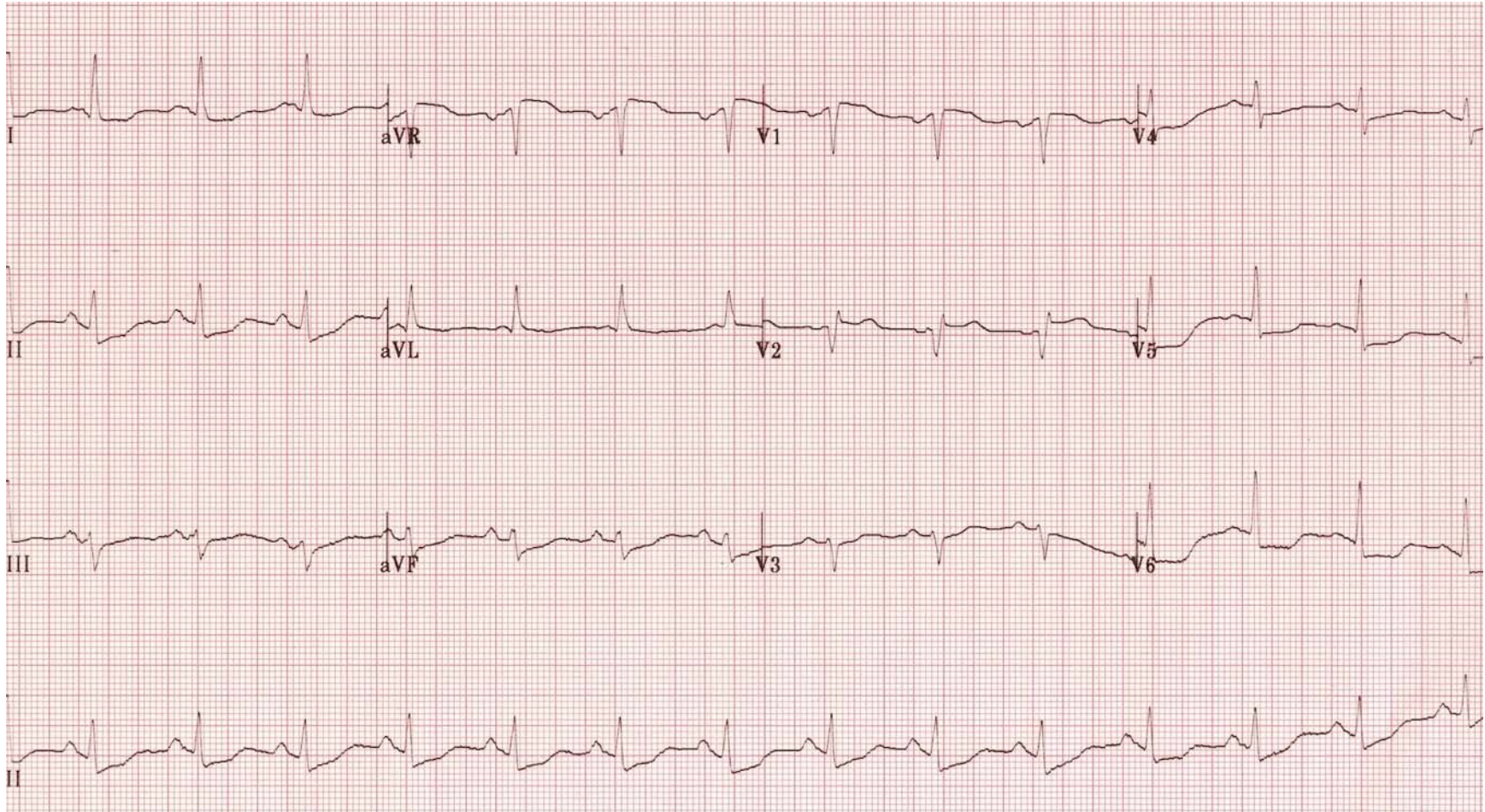
25 mm/sec 10 mm/mV F: 0 Hz W: 0-0 Hz



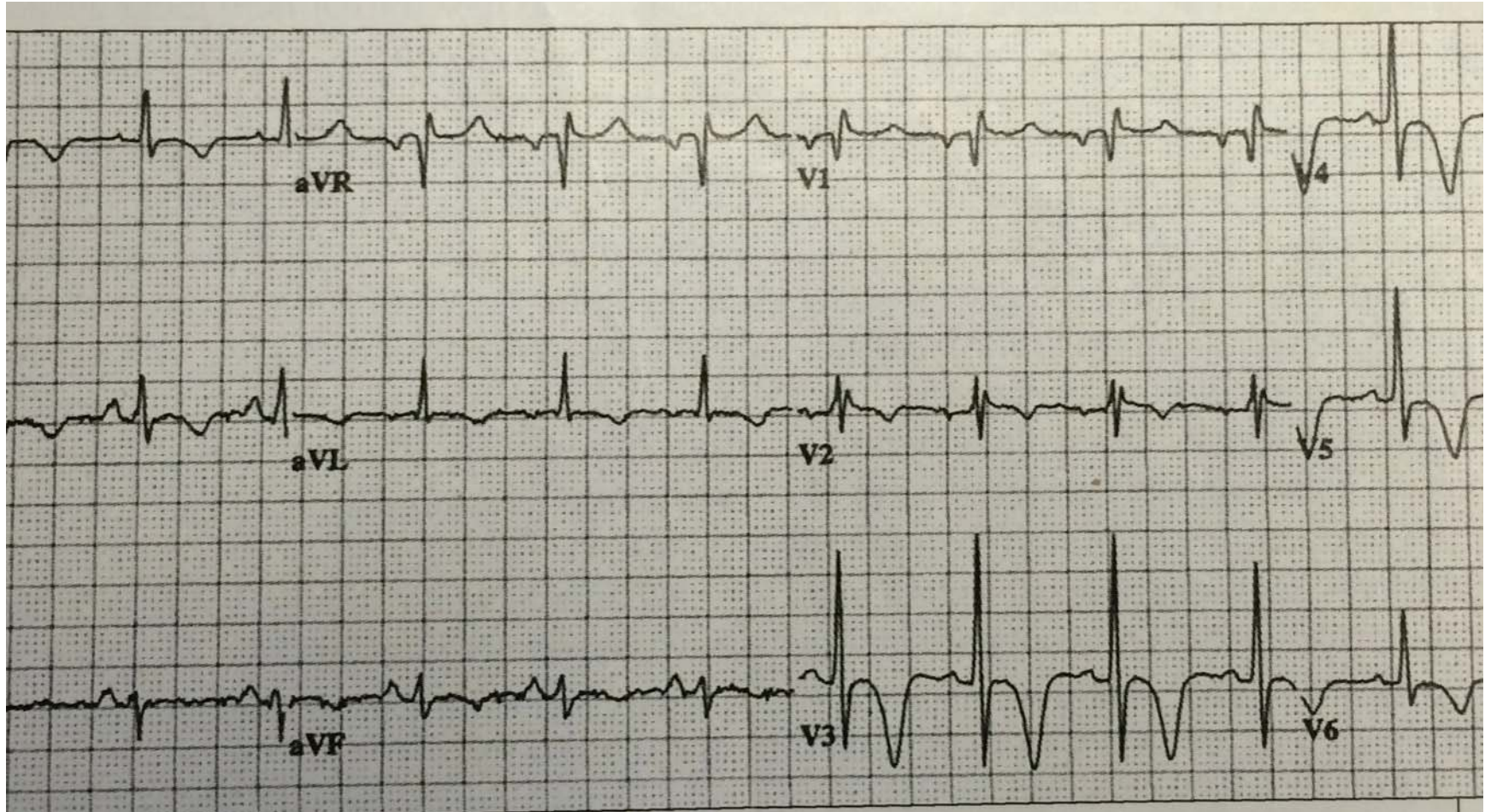
Group 2



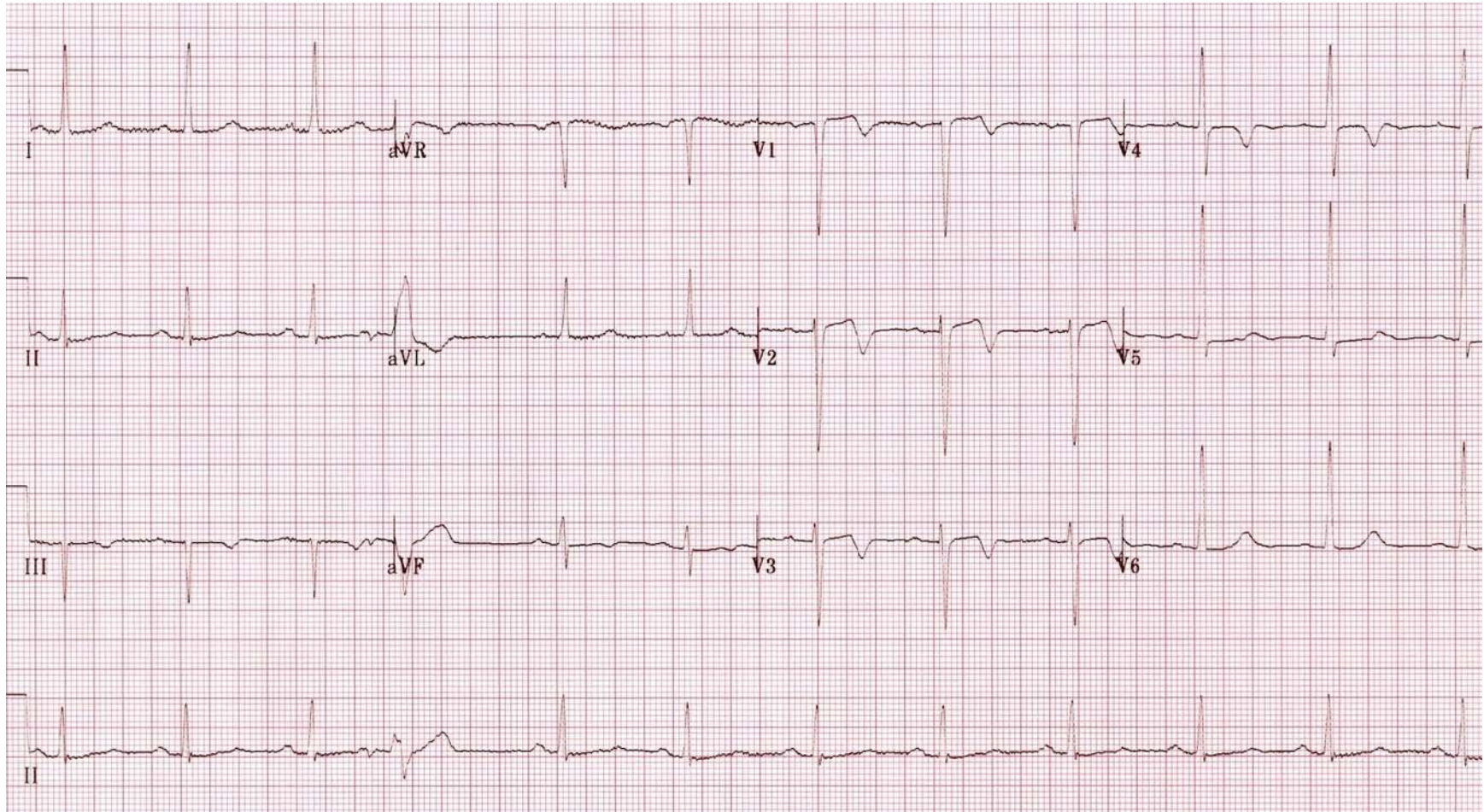
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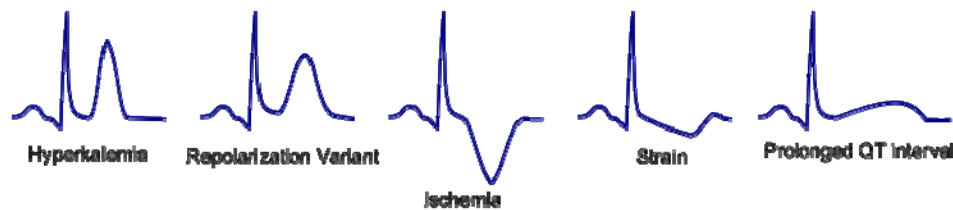
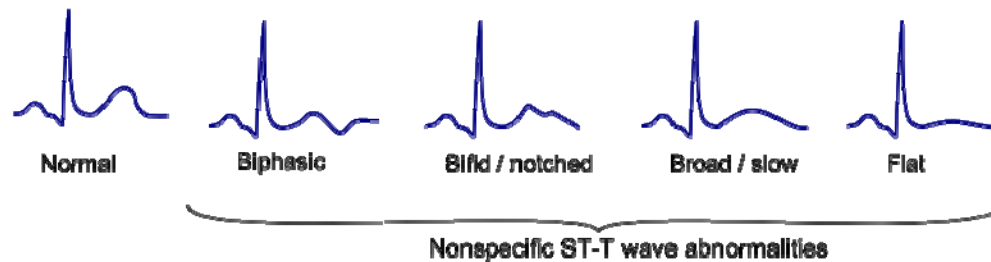
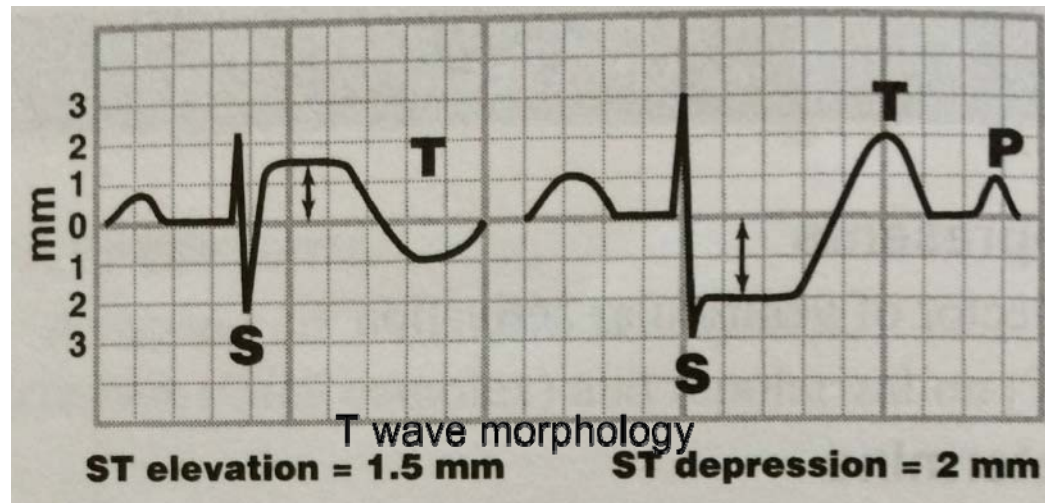
Group 2



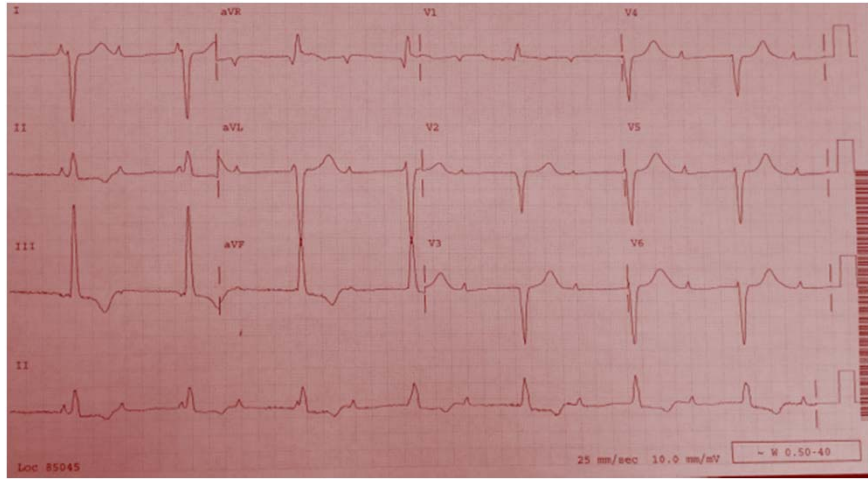
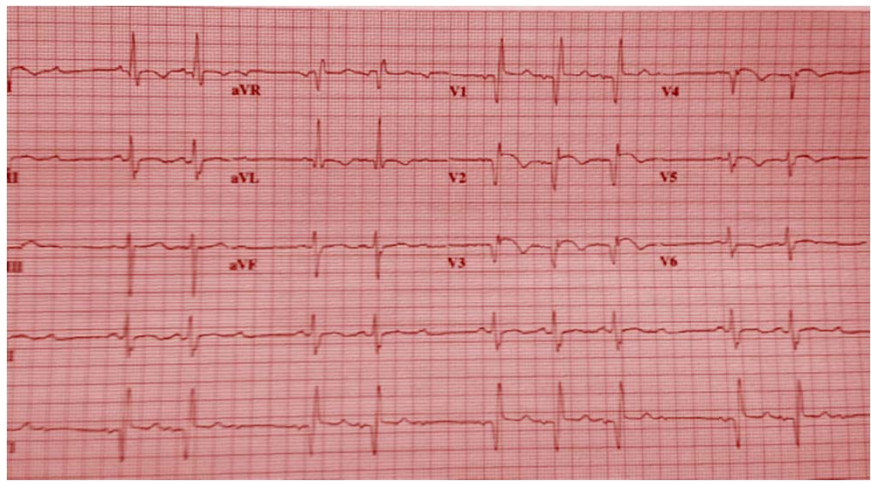
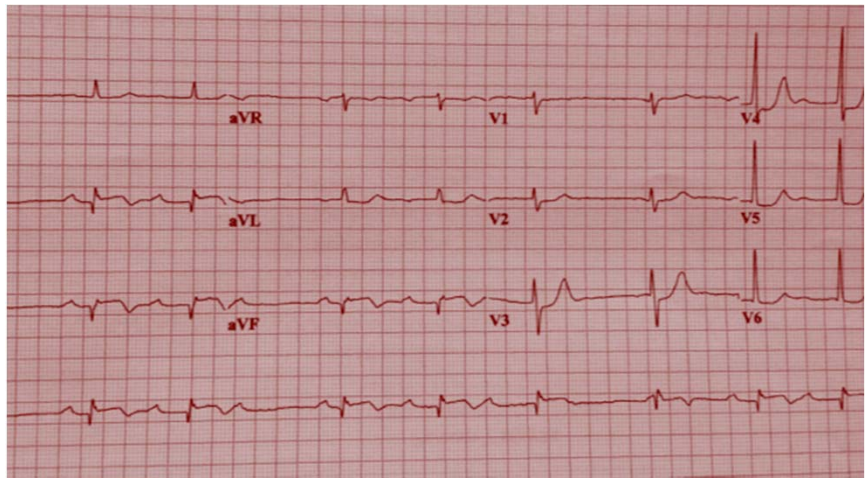
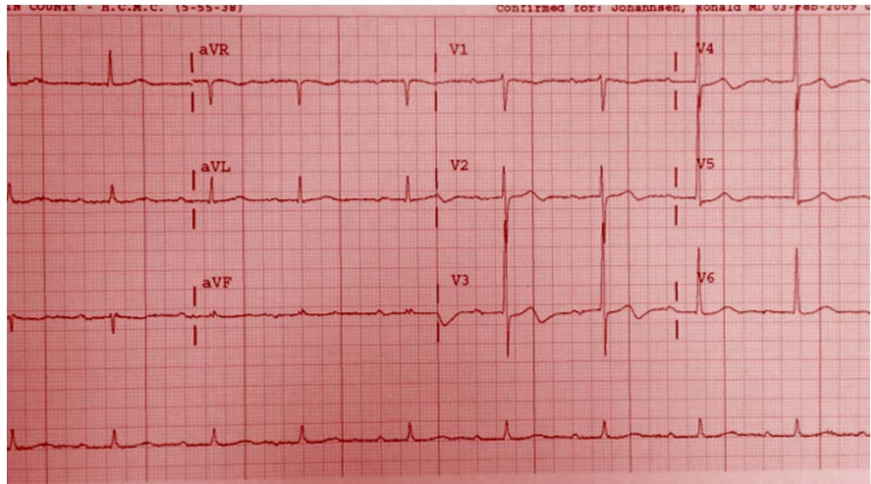
Group 2



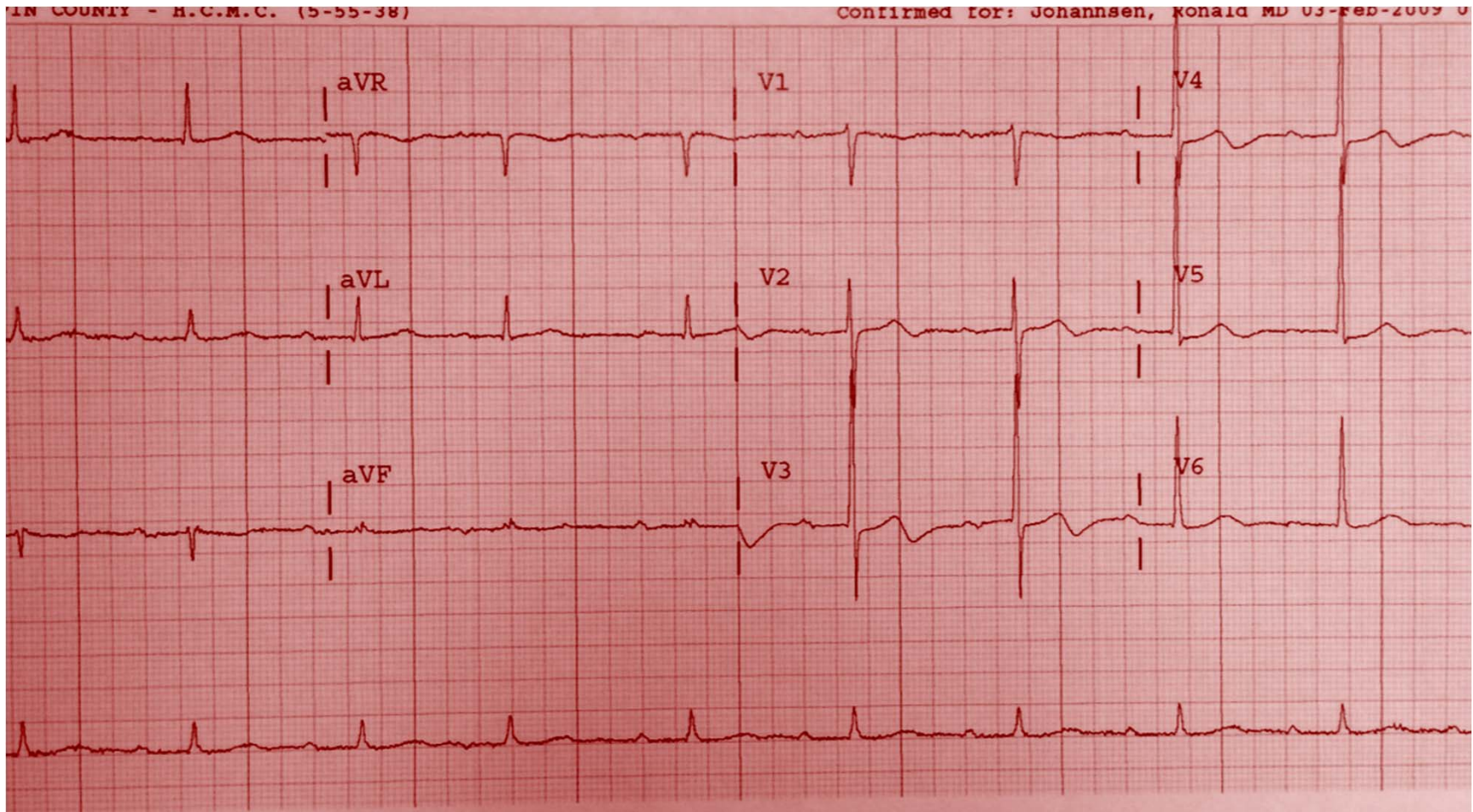
Group 2: Ischemic ST changes



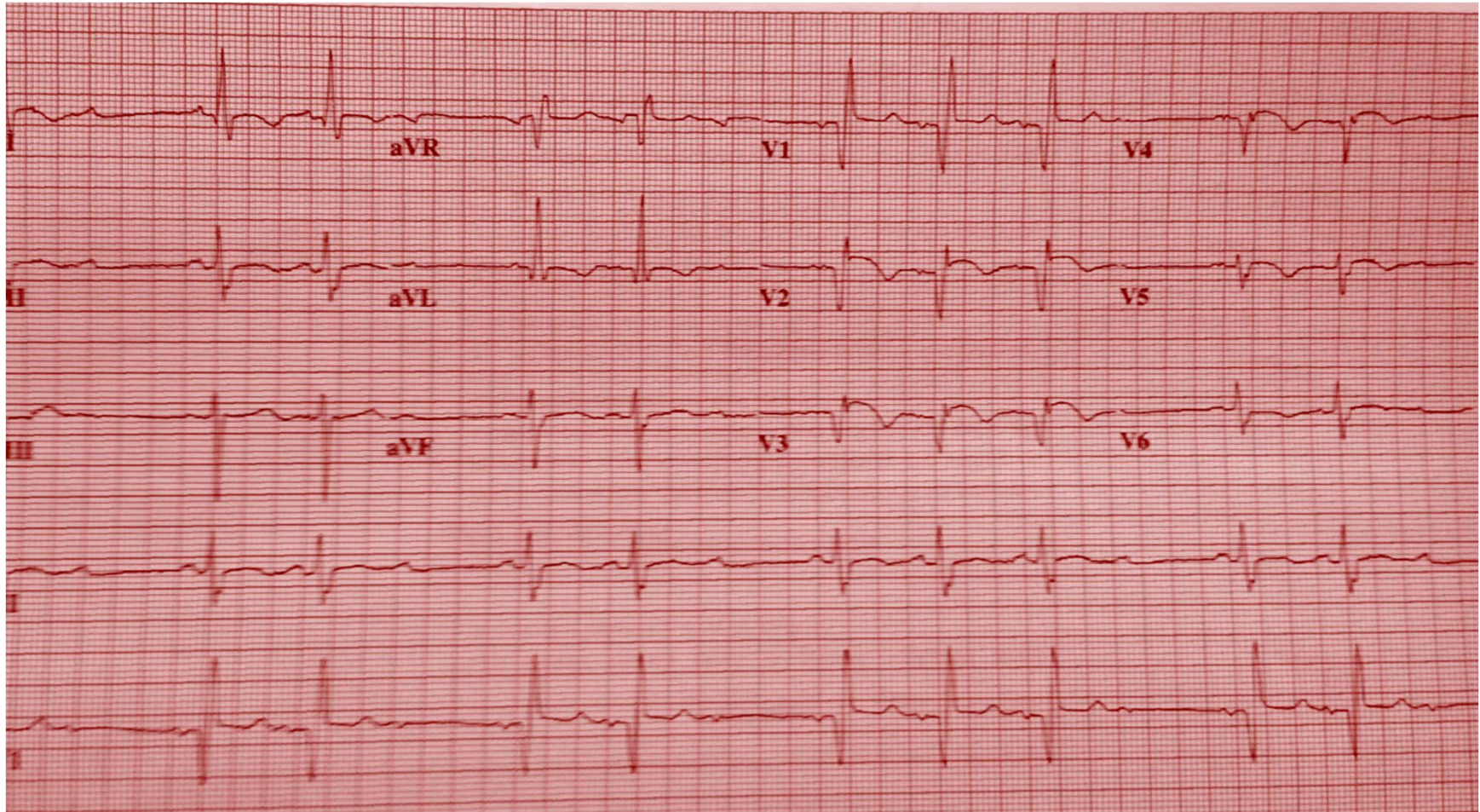
Group 3



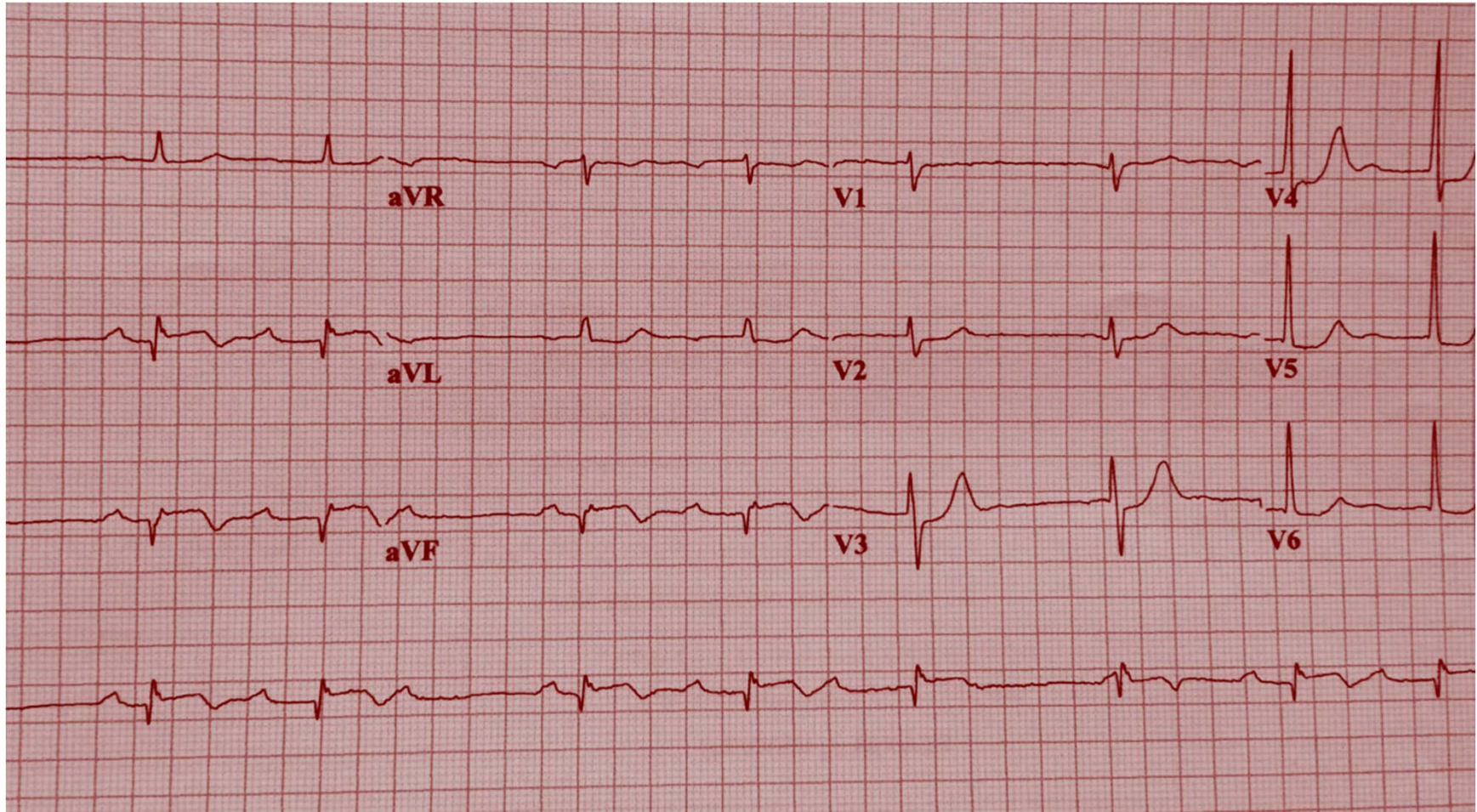
Group 3



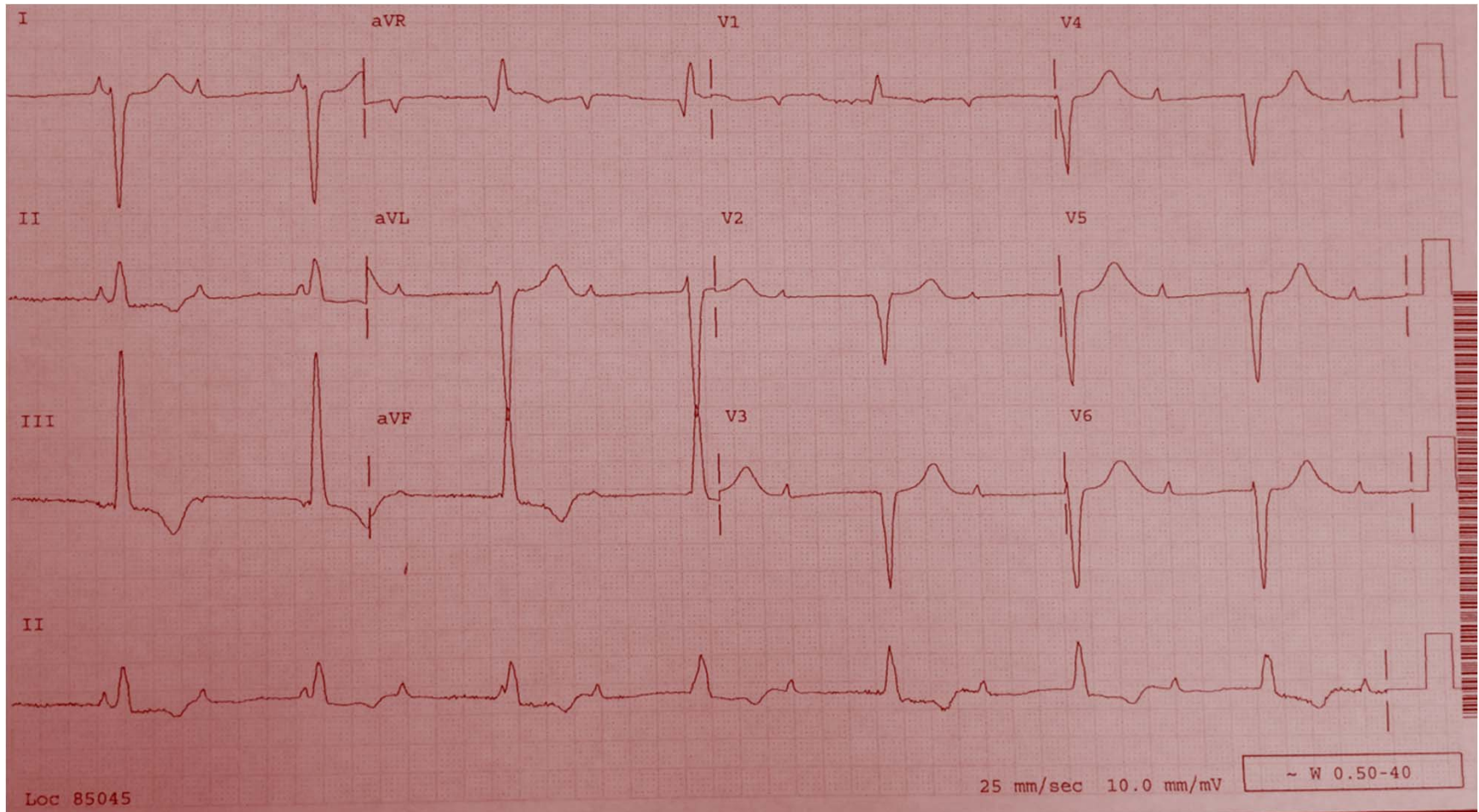
Group 3



Group 3

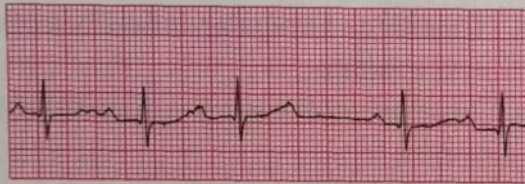


Group 3



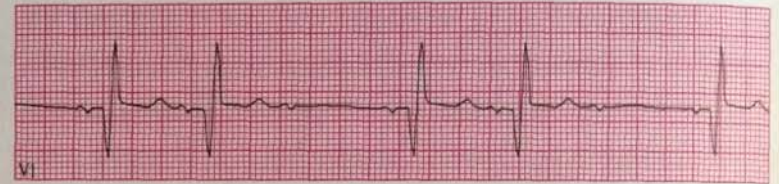
Group 3: AV Blocks

30. AV block, 2° - Mobitz Type I (Wenckebach)



- Progressive prolongation of the PR interval and progressive shortening of the RR interval until a P wave is blocked
- Note:** The progressive shortening of the RR interval is due to a decrease in the beat-to-beat increment of PR prolongation.
- RR interval containing the nonconducted P wave is less than two PP intervals

31. AV block, 2° - Mobitz Type II



- Regular sinus or atrial rhythm with intermittent nonconducted P waves and no evidence for atrial prematurity
- PR interval in the conducted beats is constant
- RR interval containing the nonconducted P wave is equal to two PP intervals

Note: Type II second-degree AV block usually occurs within or below the bundle of His; the QRS is wide in 80% of cases.

Rhythm Strip:?



Rhythm Strip: 2nd degree Type 1 AV Block



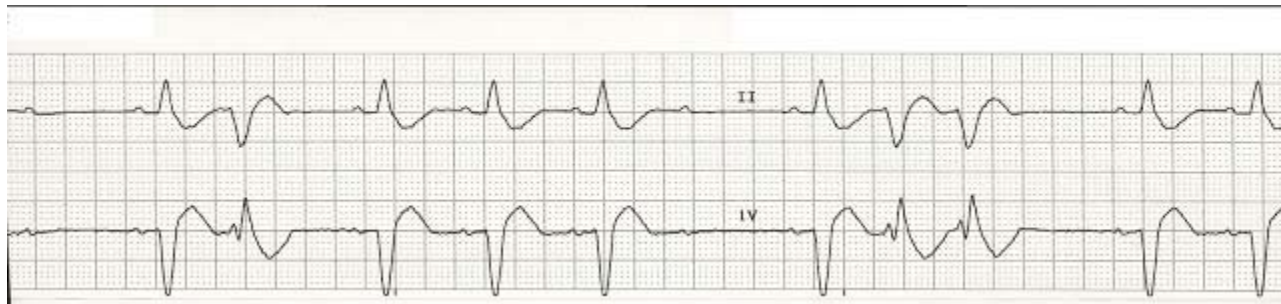
Rhythm Strip: ?



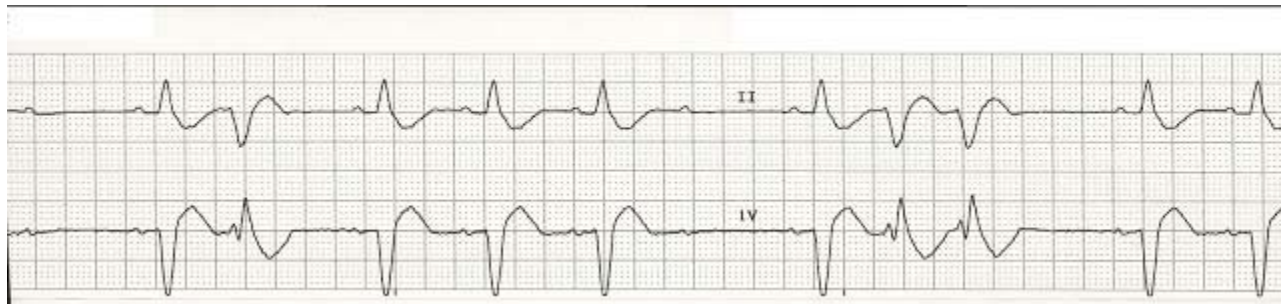
Rhythm Strip: 2nd degree AV block, type 1 or 2



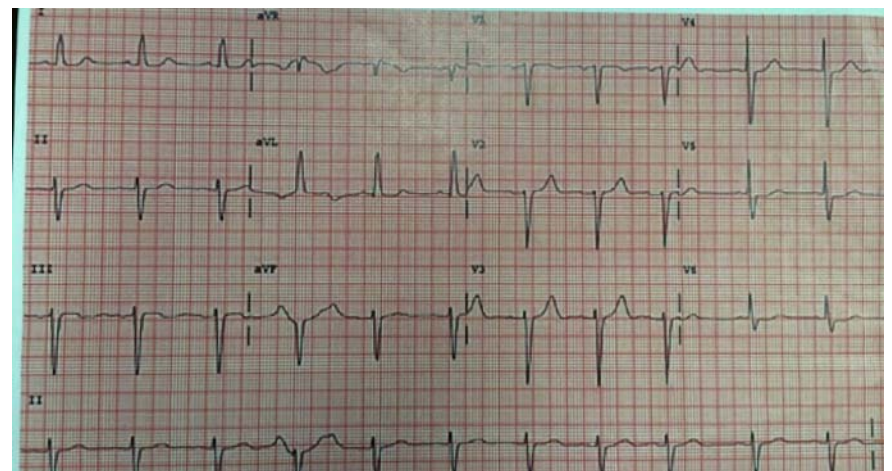
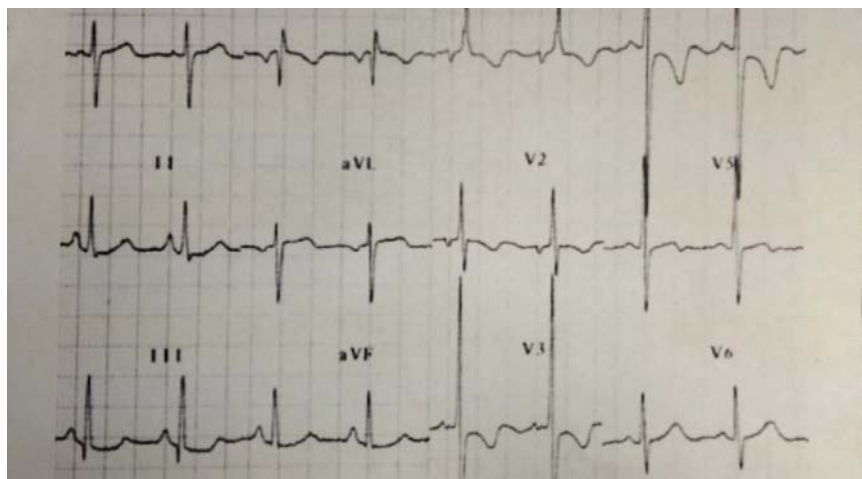
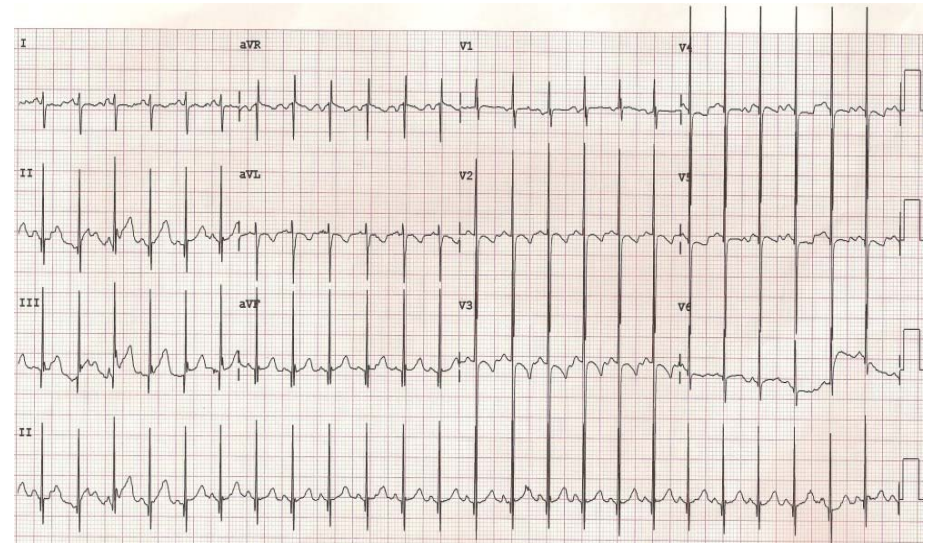
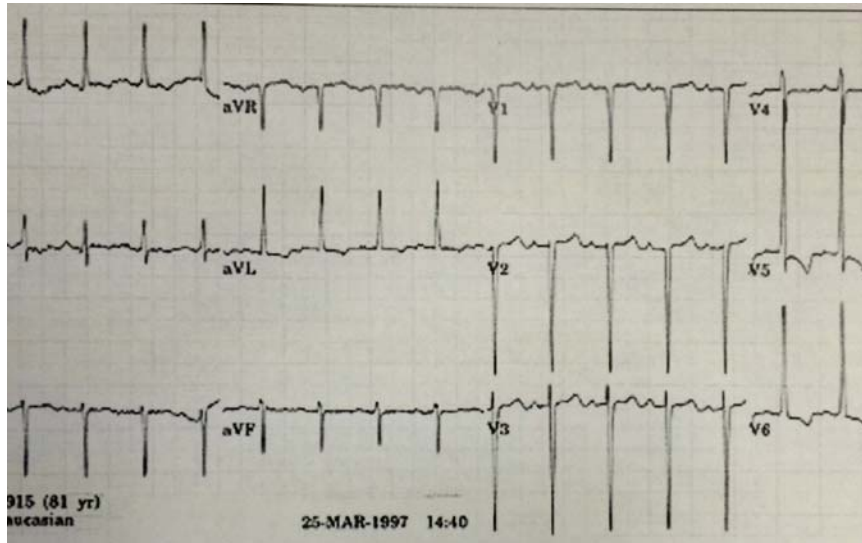
Rhythm Strip: ?



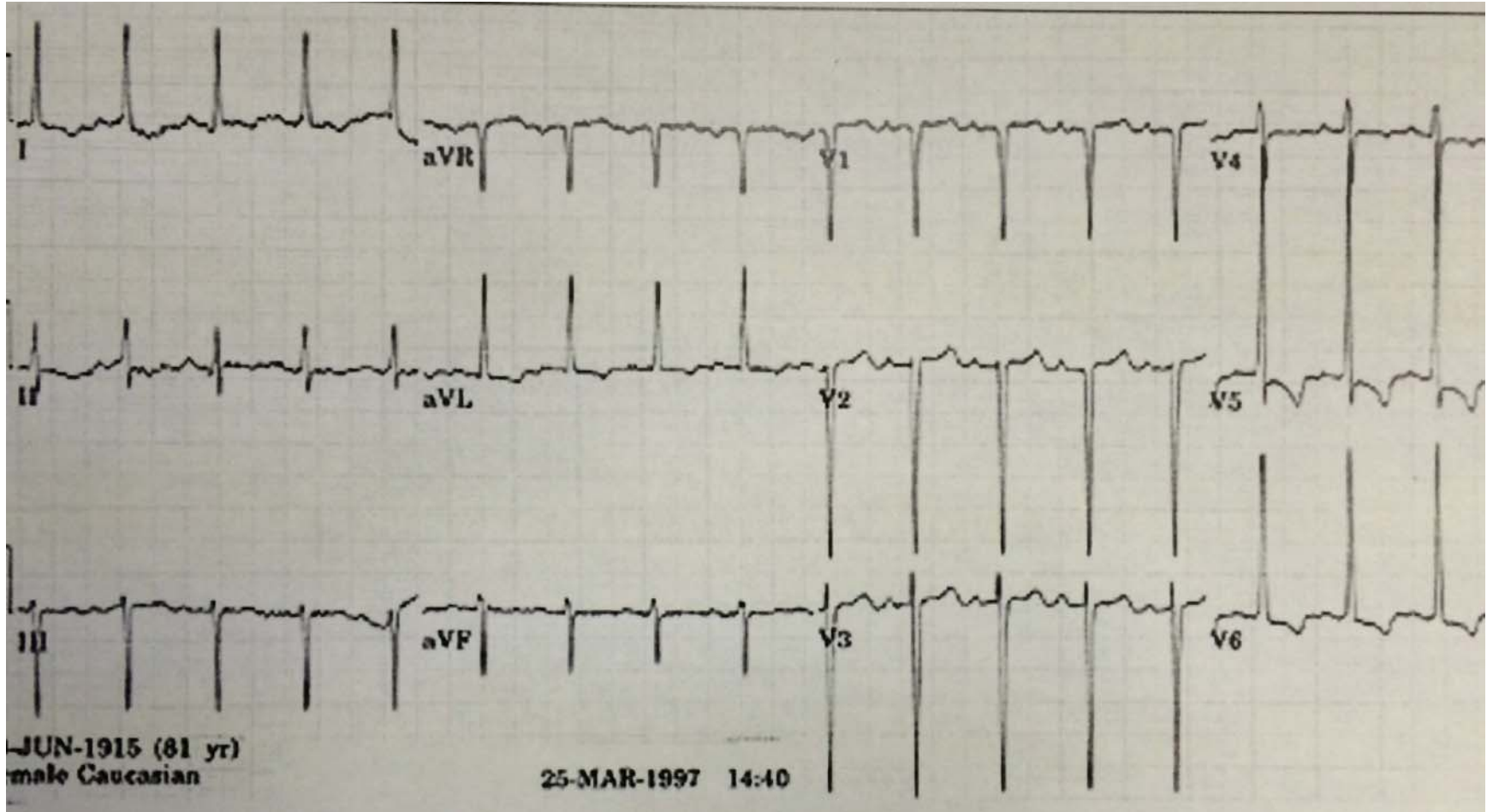
Rhythm Strip: 2nd degree AV block, type 2



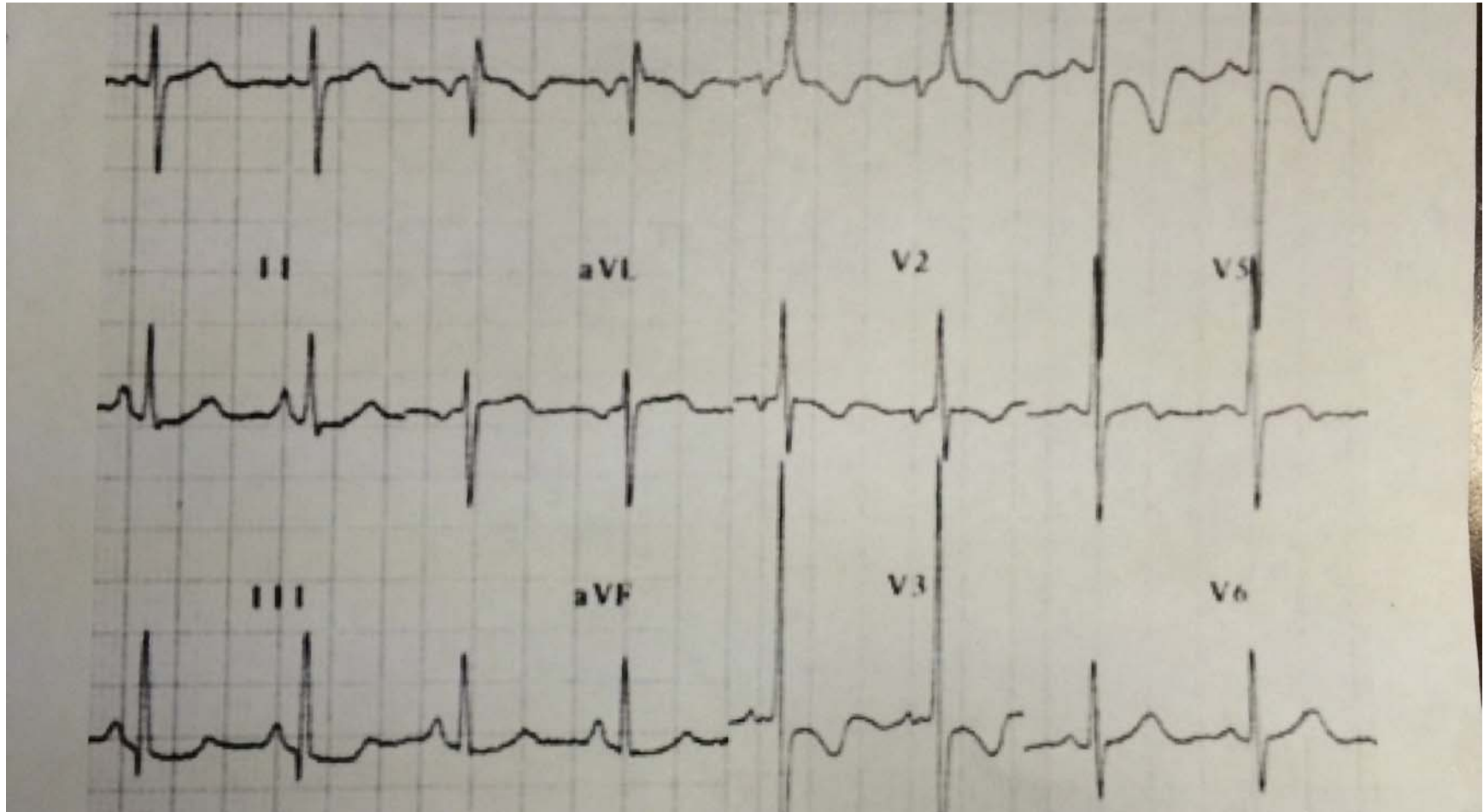
Group 4



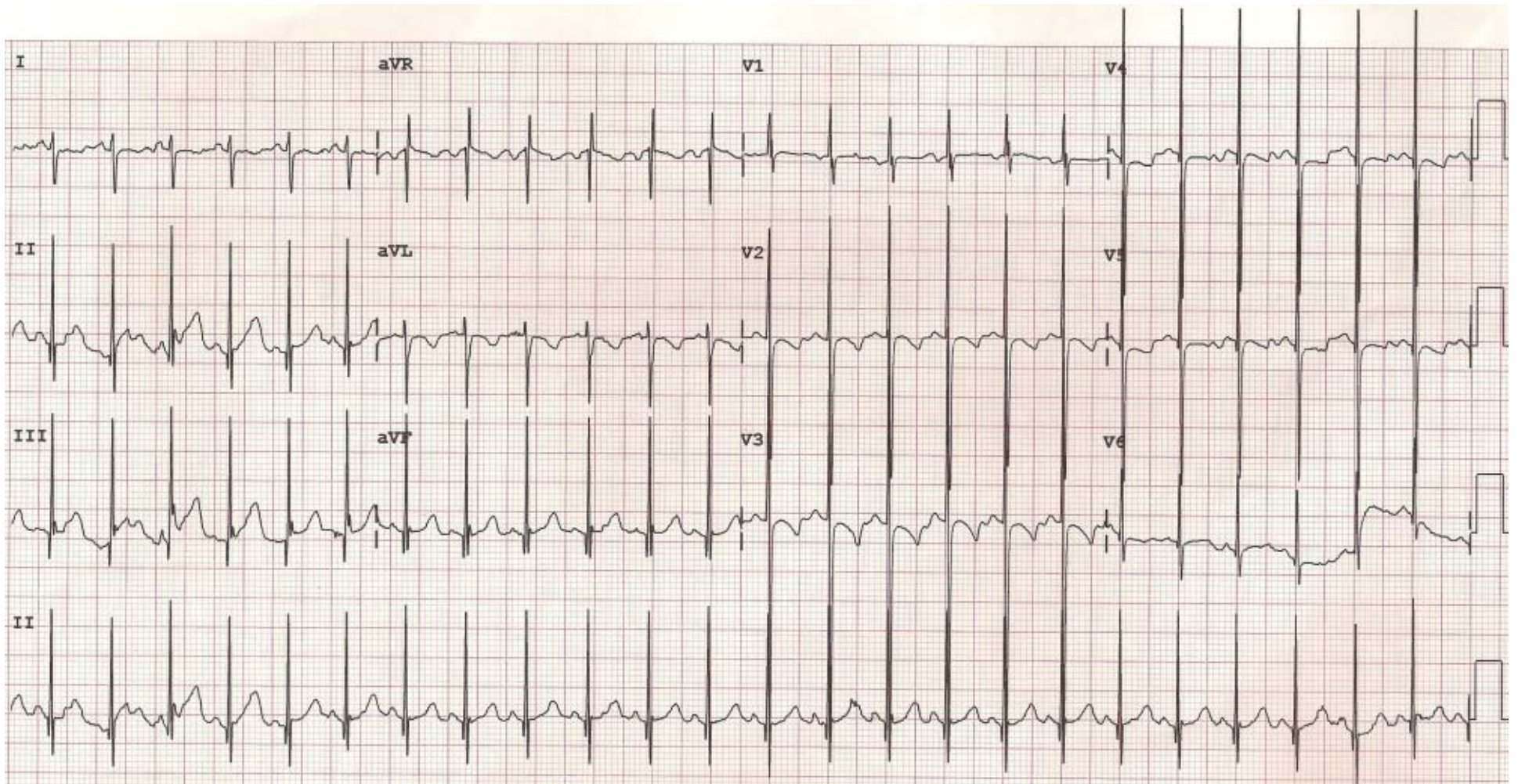
Group 4



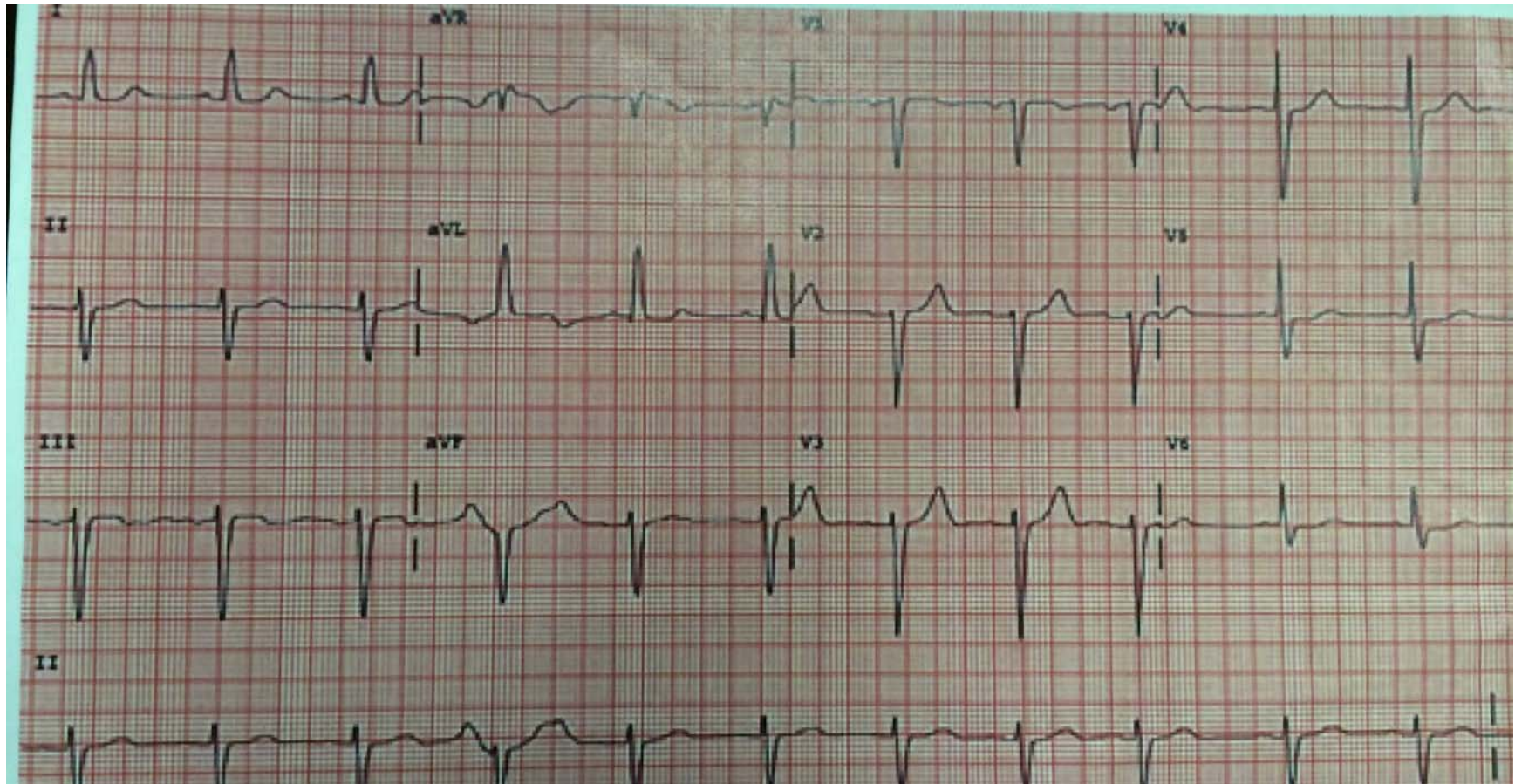
Group 4



Group 4



Group 4



Group 4: Ventricular hypertrophy

<u>Criteria in Males</u>	<u>Sens</u>	<u>Spec</u>	<u>LR+</u>	<u>LR-</u>
Cornell voltage (RaVL +SV3 >25 mm)	19.1	95.0	3.8	0.9
Max [SV1, SV2, RV5, or RV6] ≥ 30 mm	17.8	95.1	3.6	0.9
R aVL >11 mm	16.4	95.1	3.3	0.9

<u>Criteria in Females</u>	<u>Sens</u>	<u>Spec</u>	<u>LR+</u>	<u>LR-</u>
Cornell voltage (RaVL +SV3 >20 mm)	18.6	95.0	3.7	0.9
R aVL > 11 mm	10.1	98.2	5.6	0.9
RV5 or RV6 >25 mm	8.0	97.8	3.6	0.9

QRS criteria for RVH:

Right axis deviation (>90 degrees)

An R/S ratio > 1 in lead V1

An R wave > 7 mm tall in VI, (not the R' of RBBB)

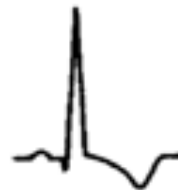
An rsR' complex in V 1 (R' > 10 mm)

An S wave > 7 mm deep in leads V5 or V6

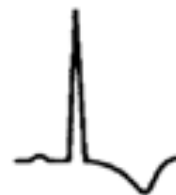
CLASSICAL:
LVH voltage with
typical repol.
abnormalities
("strain")



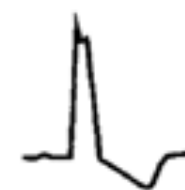
LVH voltage with
typical
repolarization
abnormalities and
QRS widening



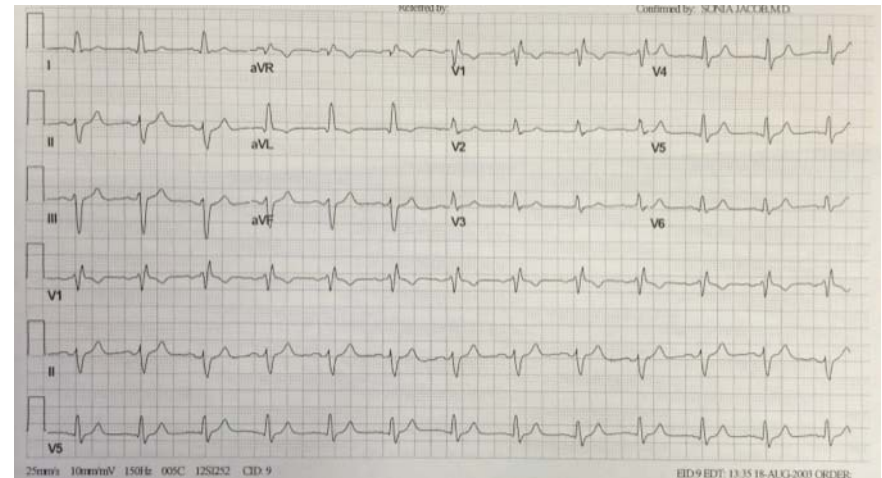
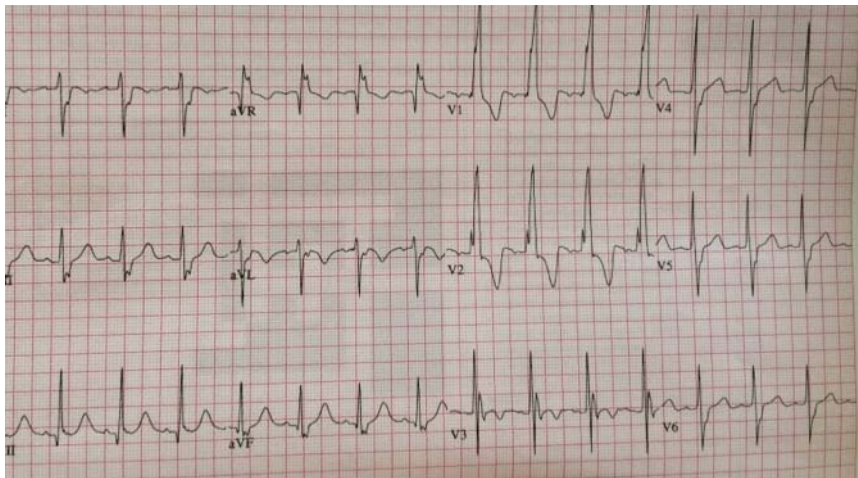
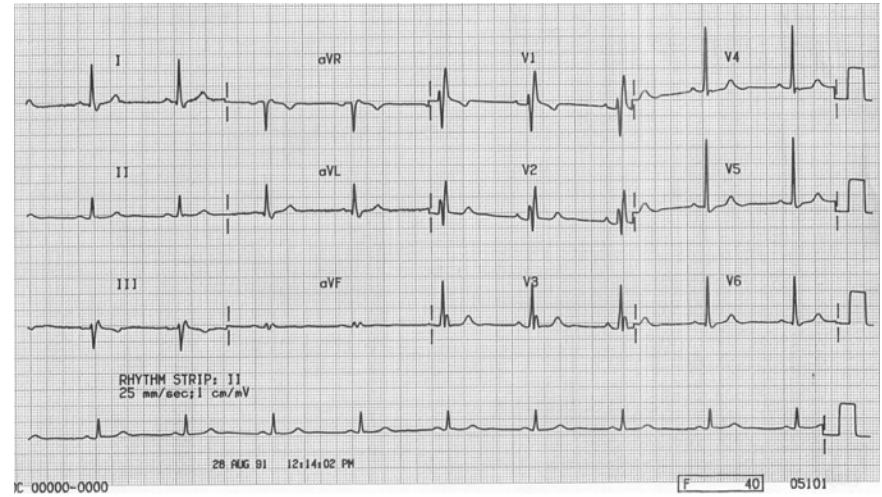
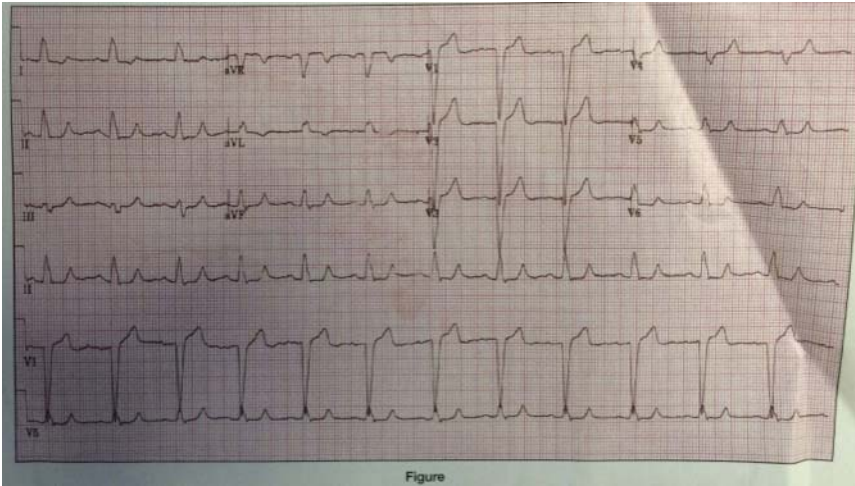
Incomplete
LBBB
(absent septal
Q in leads I
and V6)



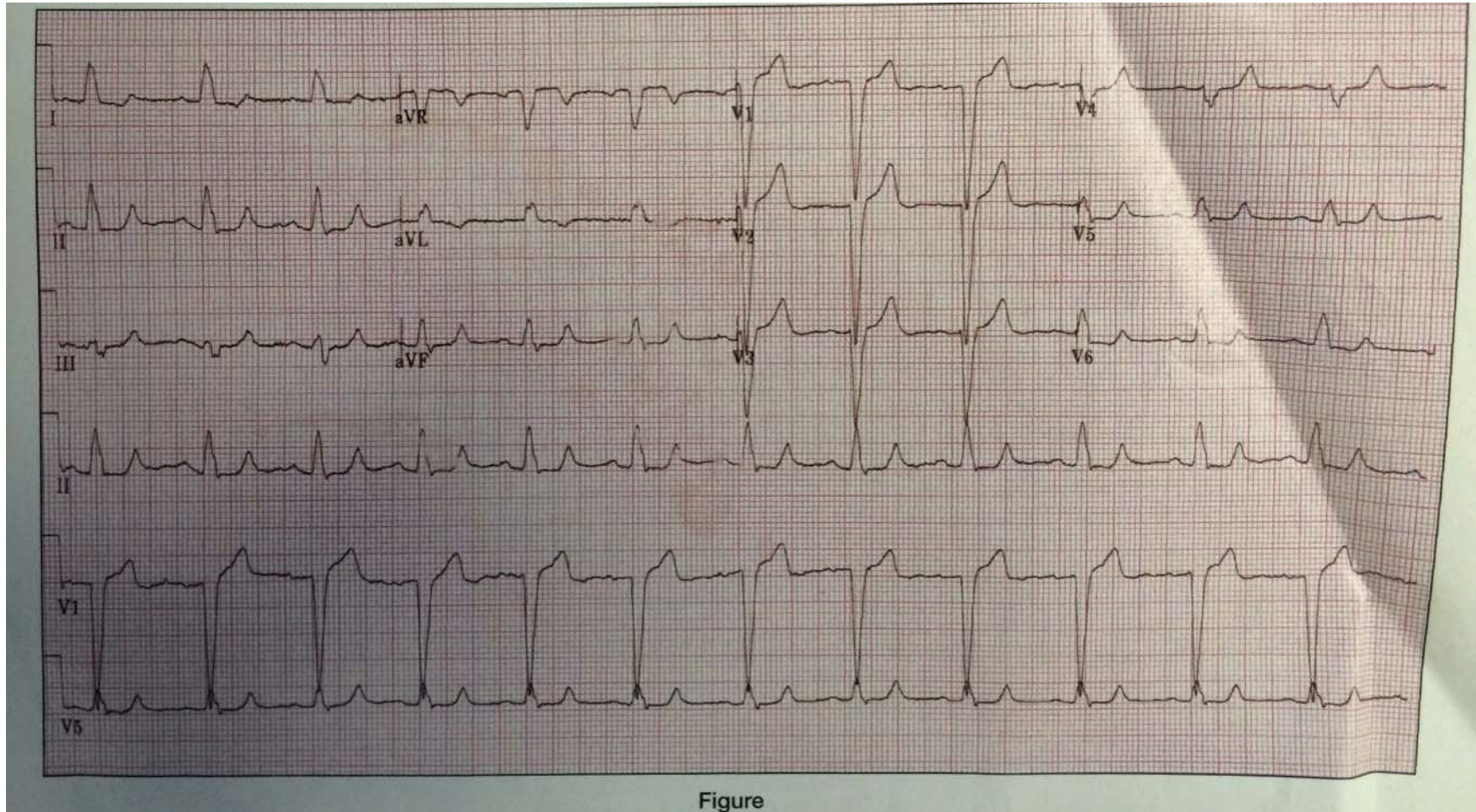
Complete
LBBB



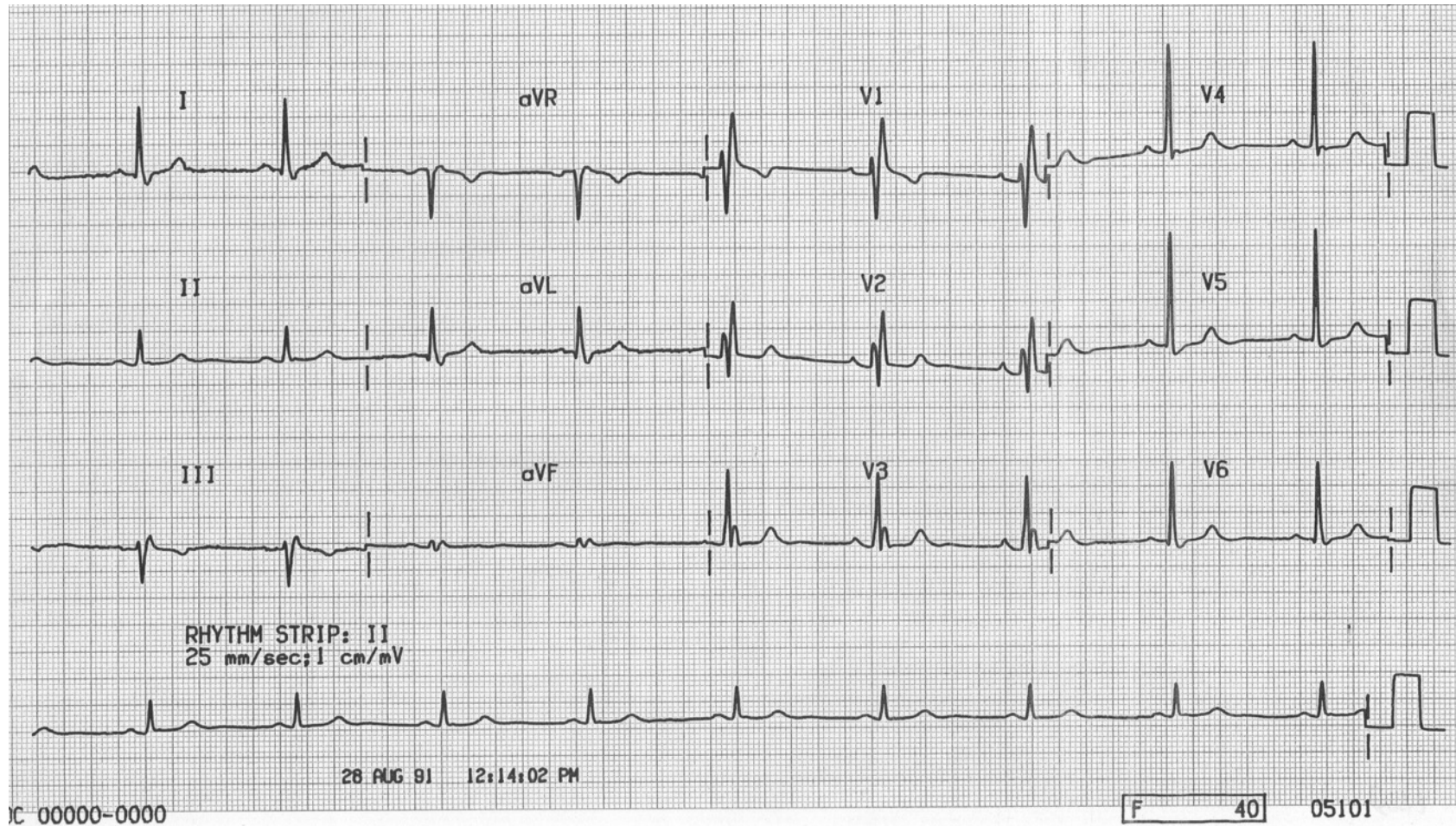
Group 5



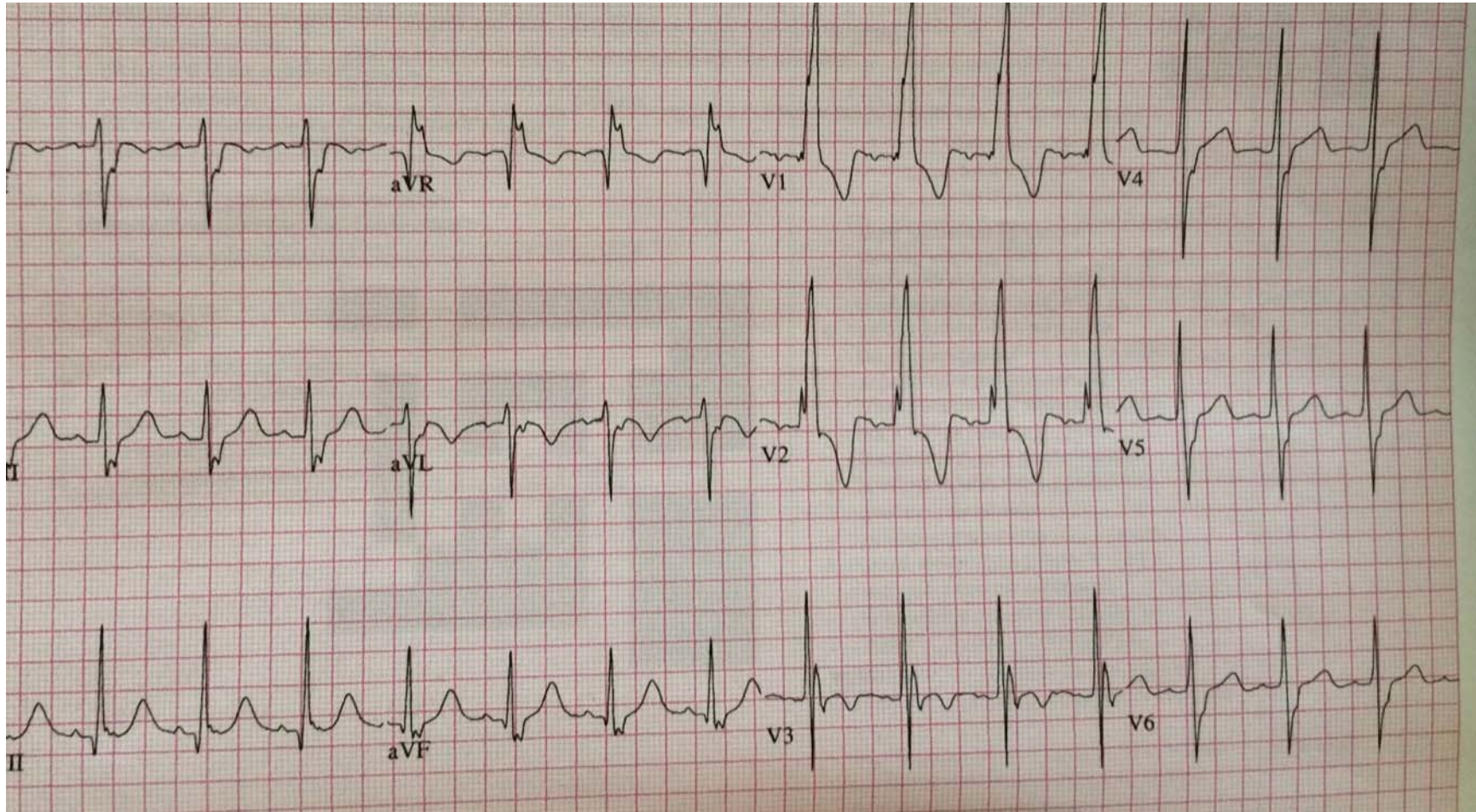
Group 5



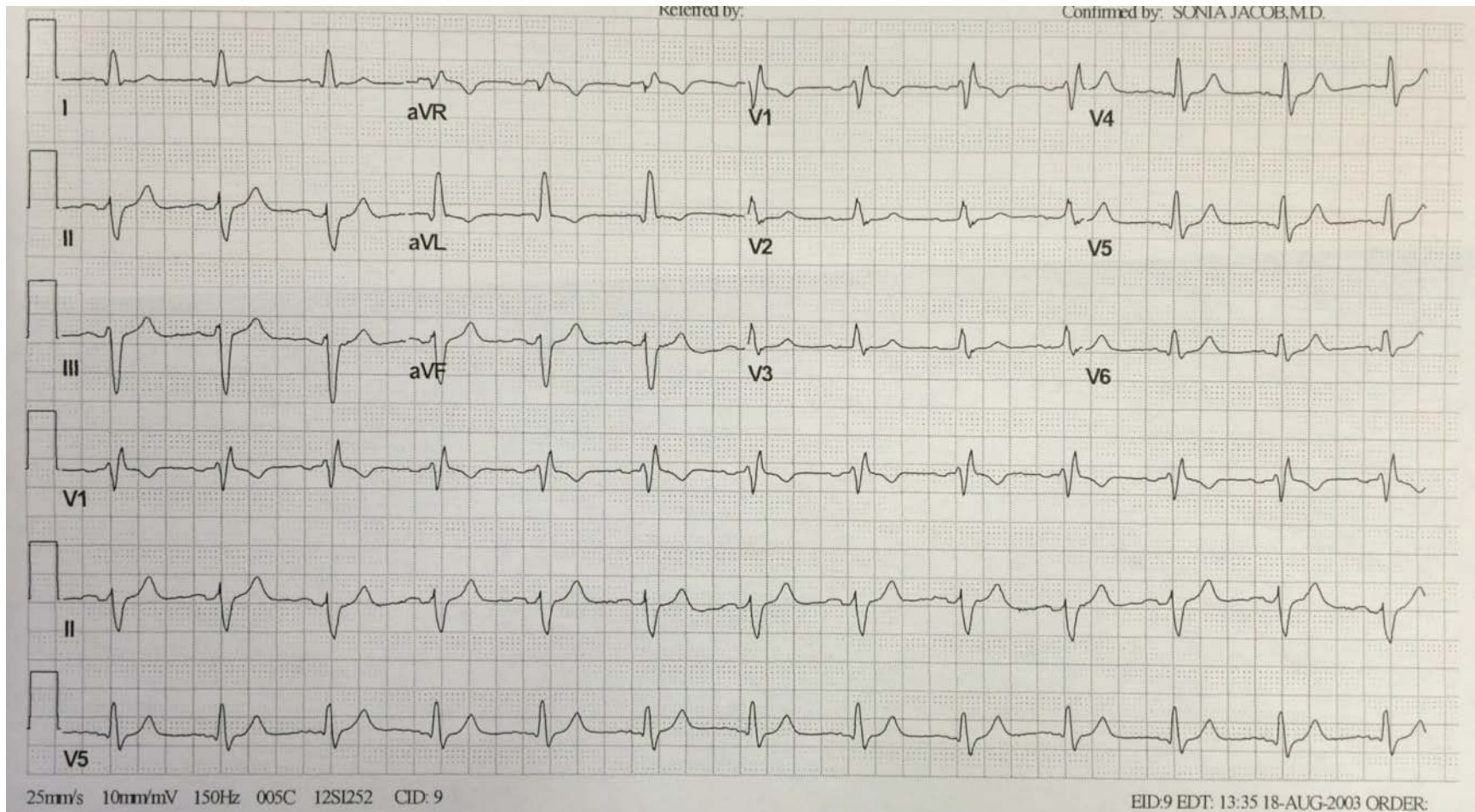
Group 5



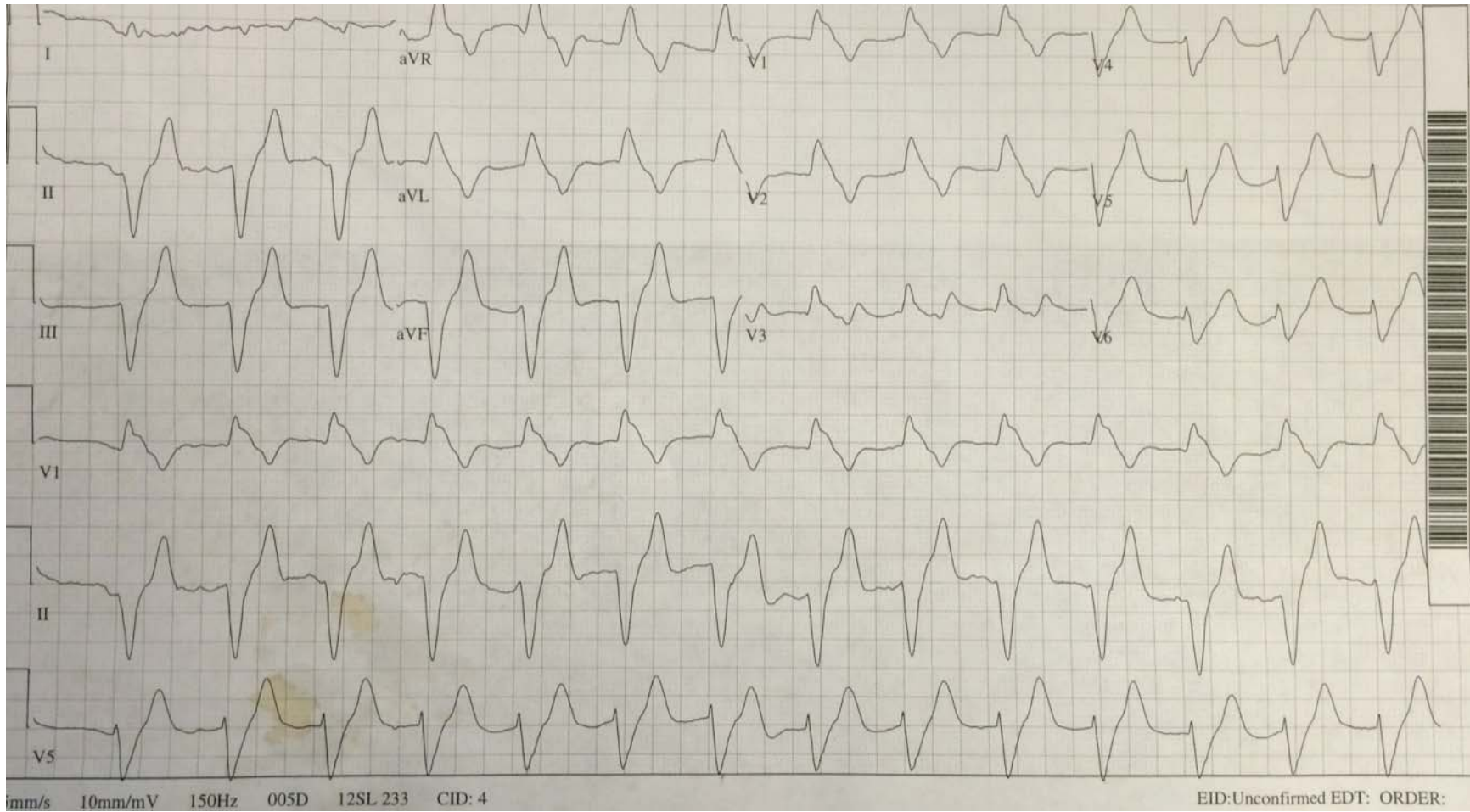
Group 5



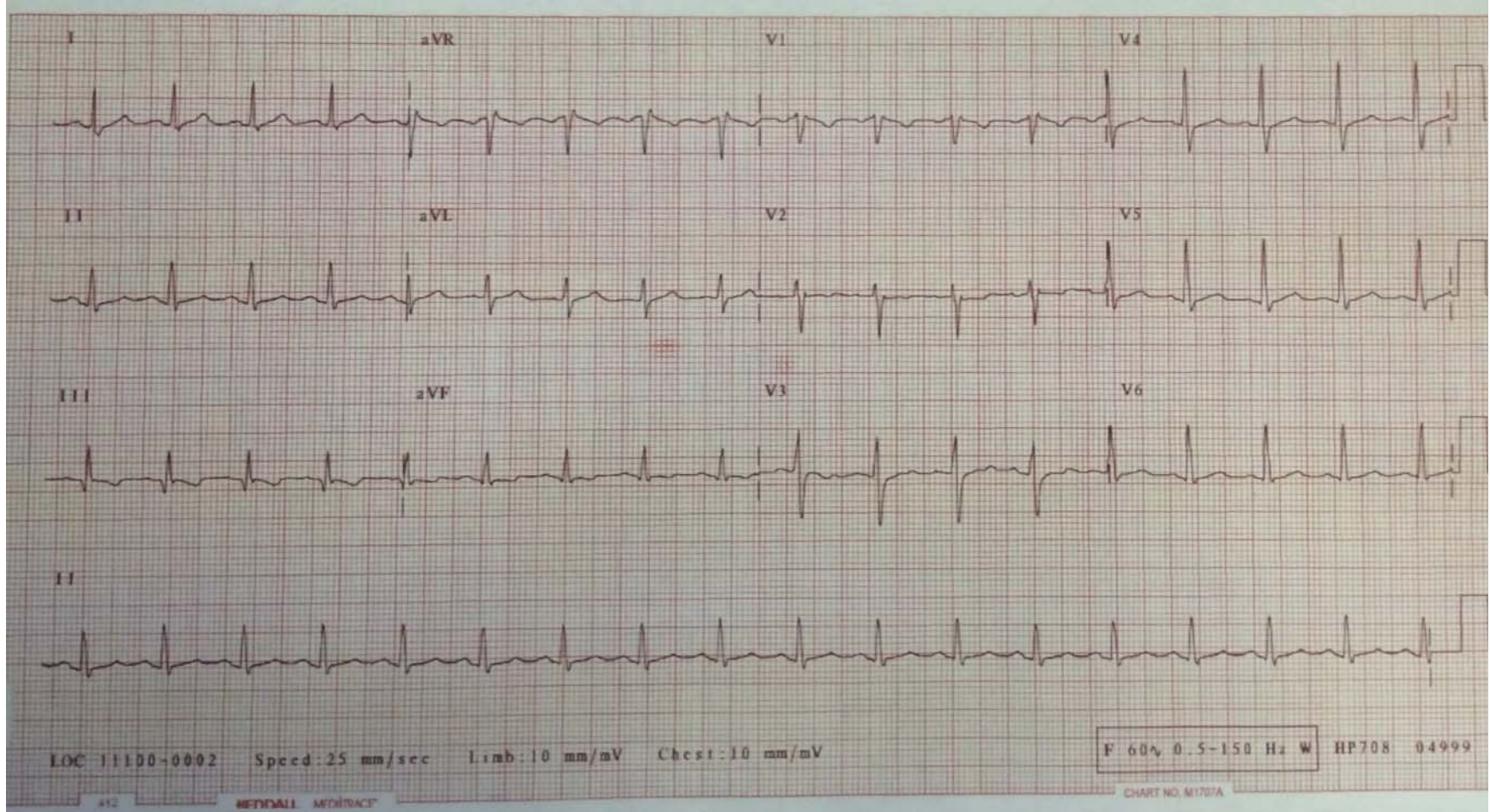
Group 5



Group 5



Group 5



Group 5: Bundle Branch Blocks

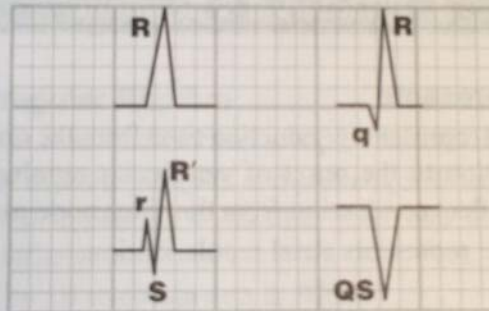
5. QRS Duration

What it Represents

Duration of ventricular activation

How to Measure

In seconds, from the beginning to the end of the QRS (or QS) complex



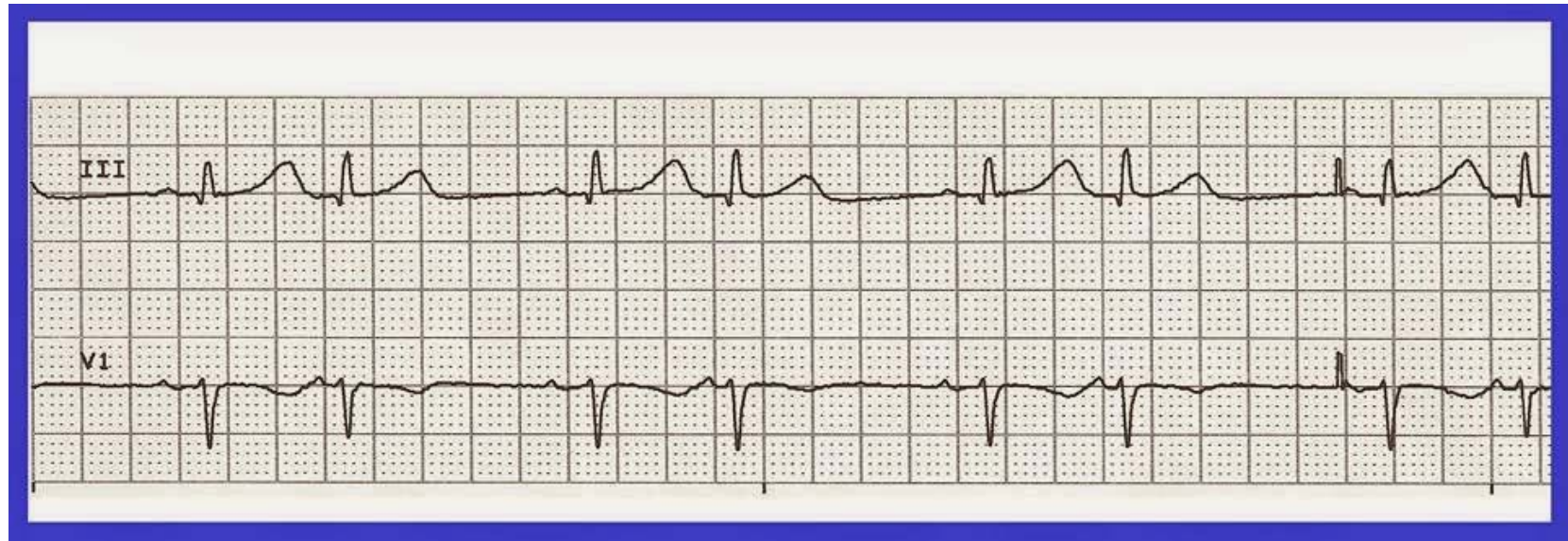
QRS duration = 1.5 small boxes = 0.06 sec.

Definitions

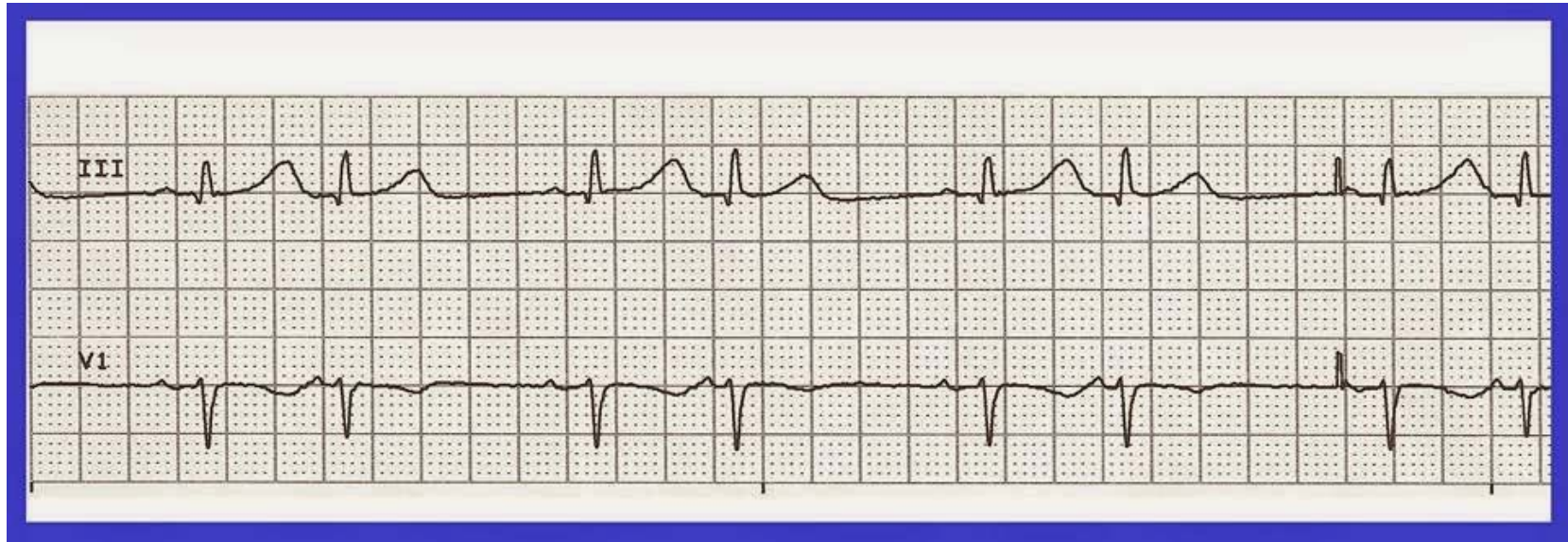
- Normal QRS duration: < 0.10 seconds
- Increased QRS duration: ≥ 0.10 seconds

Note: For the purposes of establishing a differential diagnosis, it is often useful to distinguish moderate prolongation of the QRS (0.10 to ≤ 0.12 seconds) from marked prolongation of the QRS (> 0.12 seconds)

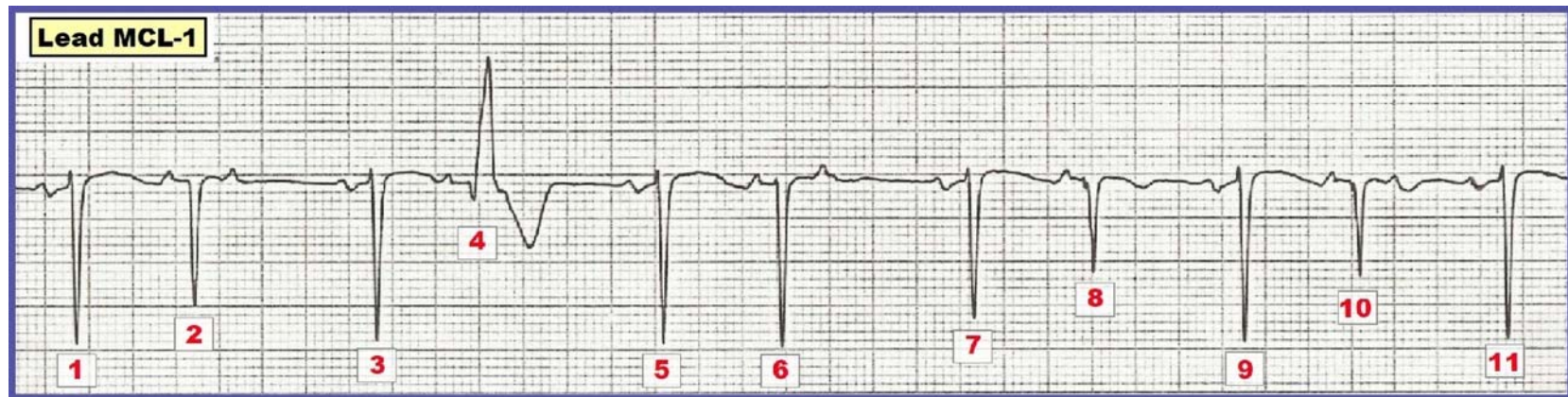
Rhythm Strip:?



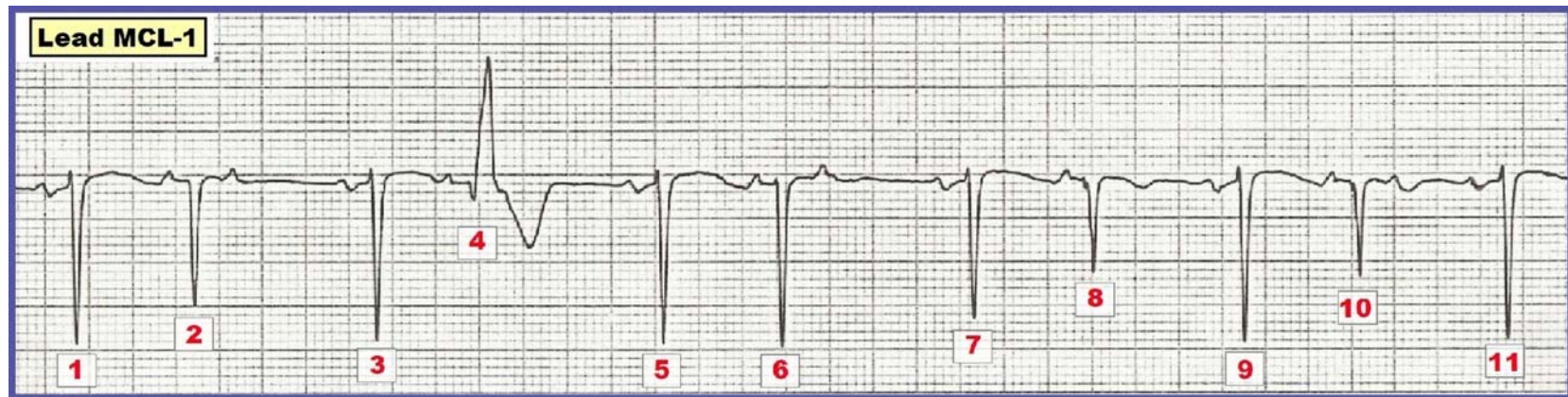
Rhythm Strip: Premature Atrial Contractions



Rhythm Strip:?

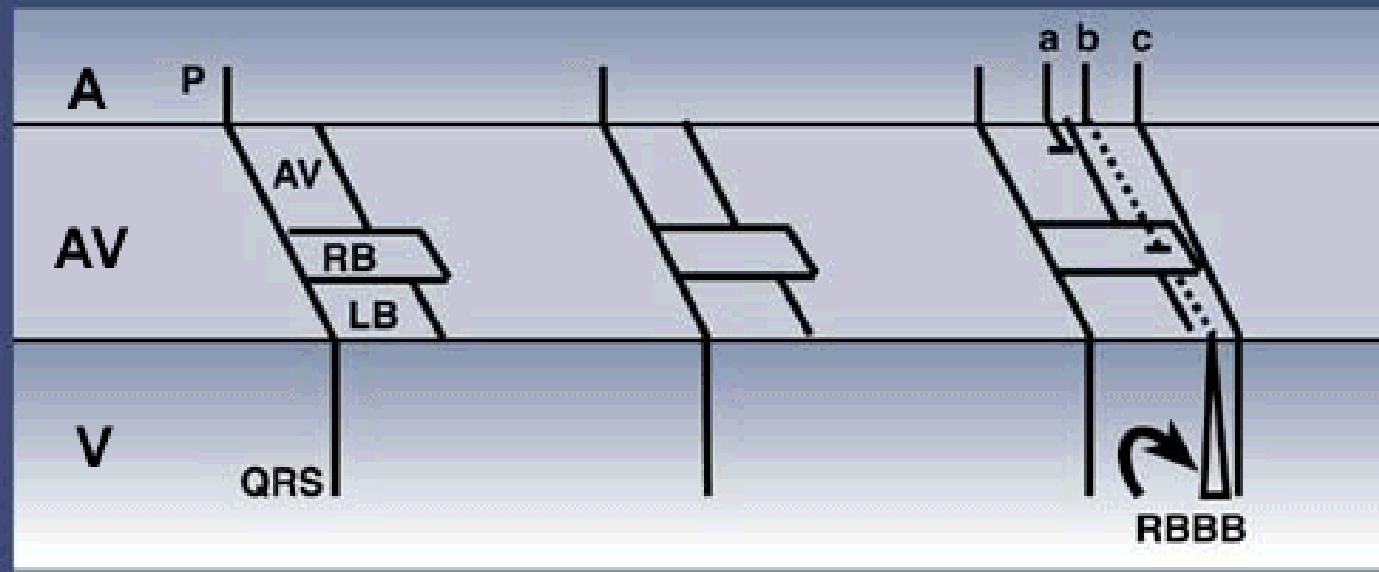


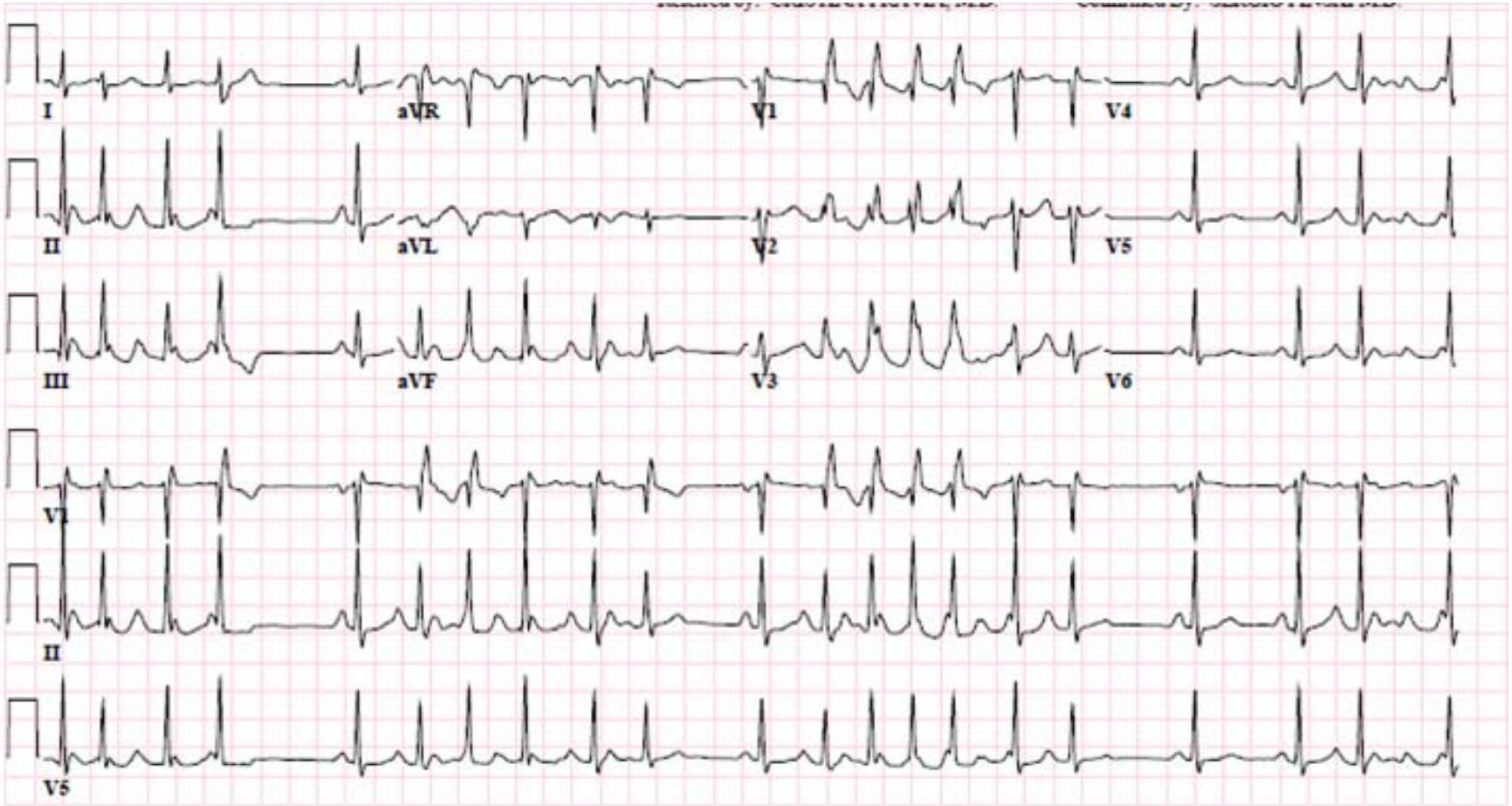
Rhythm Strip: Premature Atrial Contractions with Aberrant Conduction



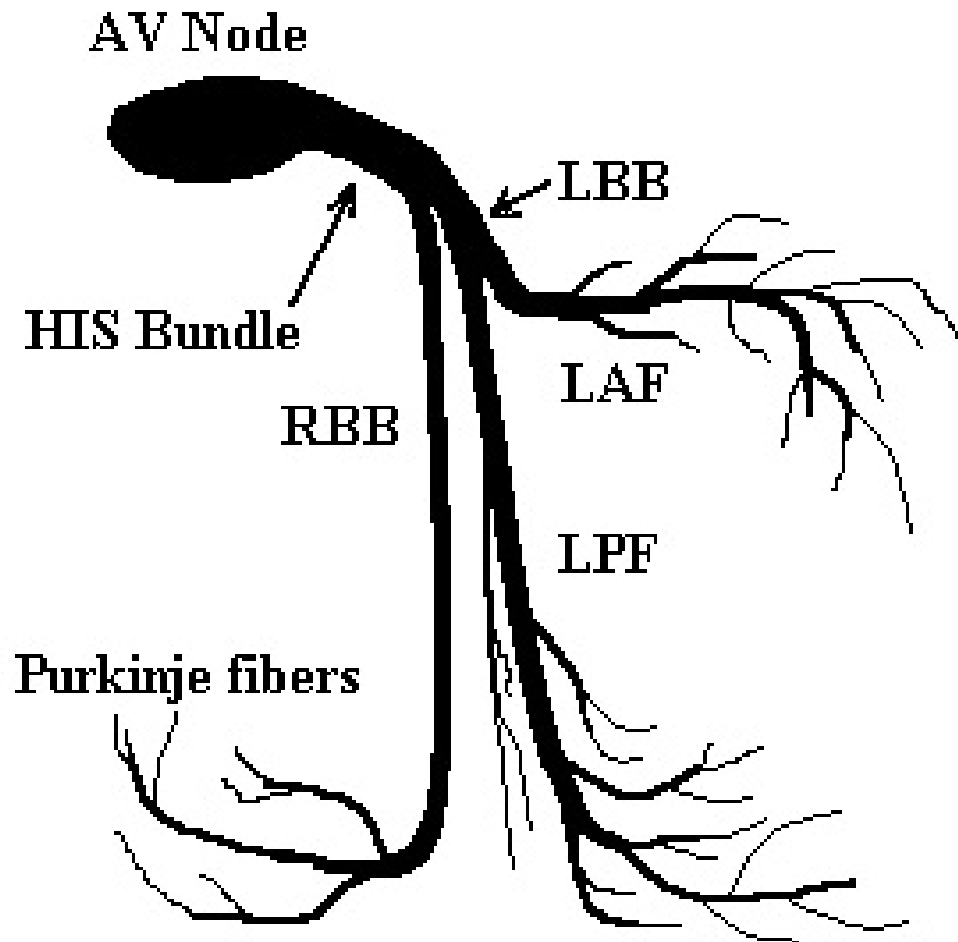
The Three Fates of PACS

1





Effect of Blocks on Axis

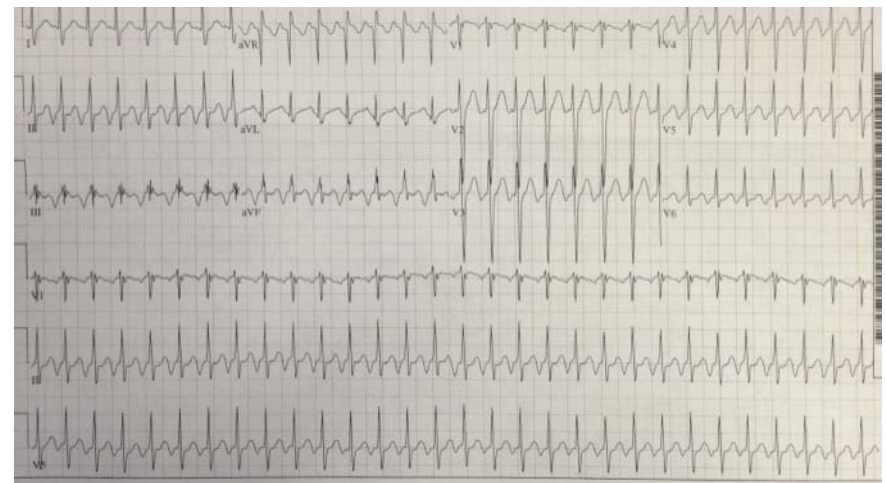
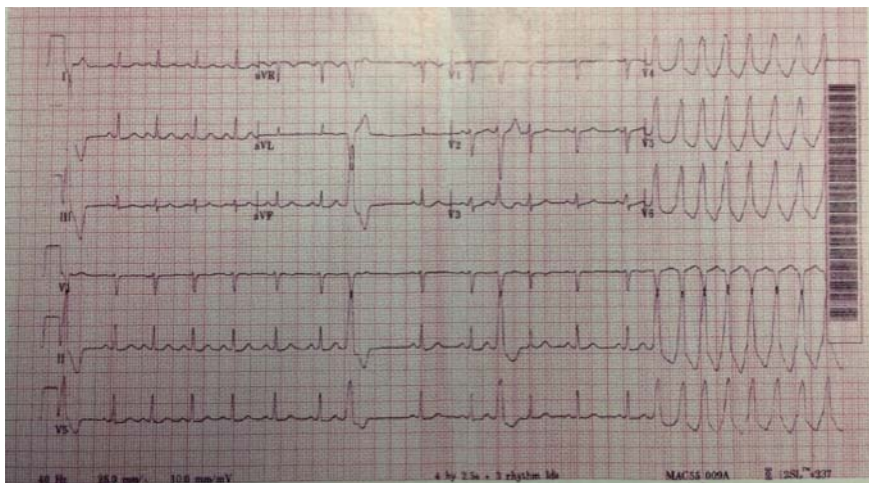
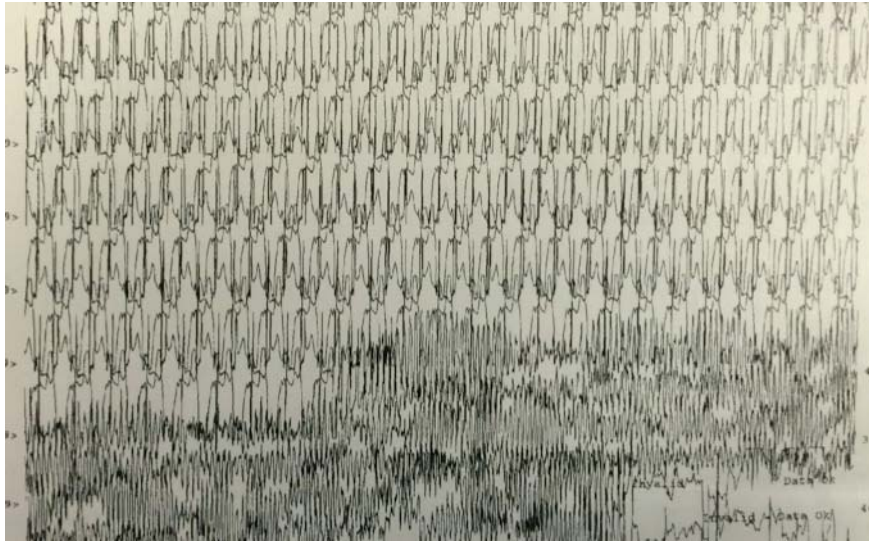


RBBB:
Axis unaffected (determined by LBB)

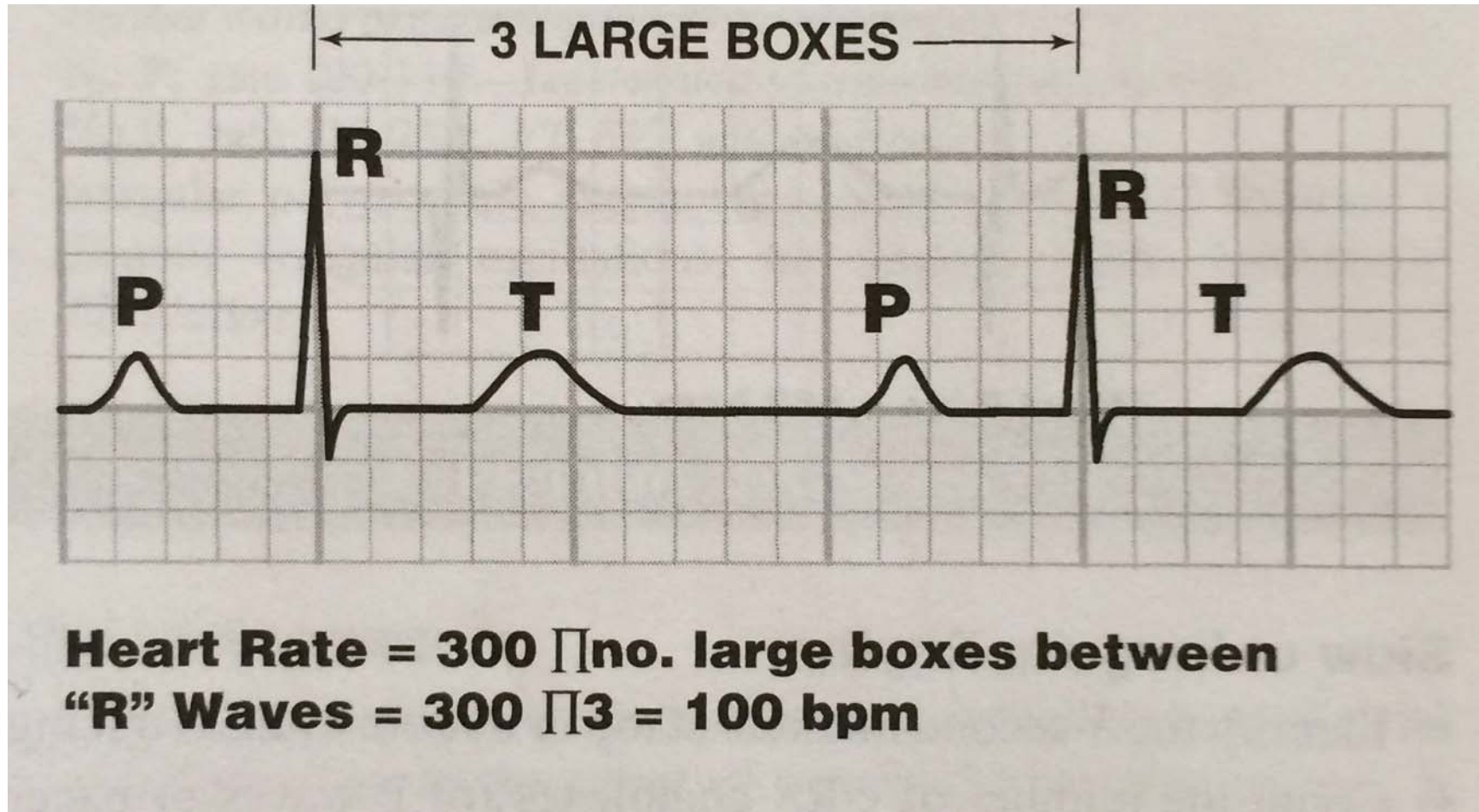
LPFB:
Initial depolarization lateral
QRS axis down and to the right
Negative in lateral leads

LAFB:
Initial depolarization inferior
QRS axis up and to the left
Negative in inferior leads

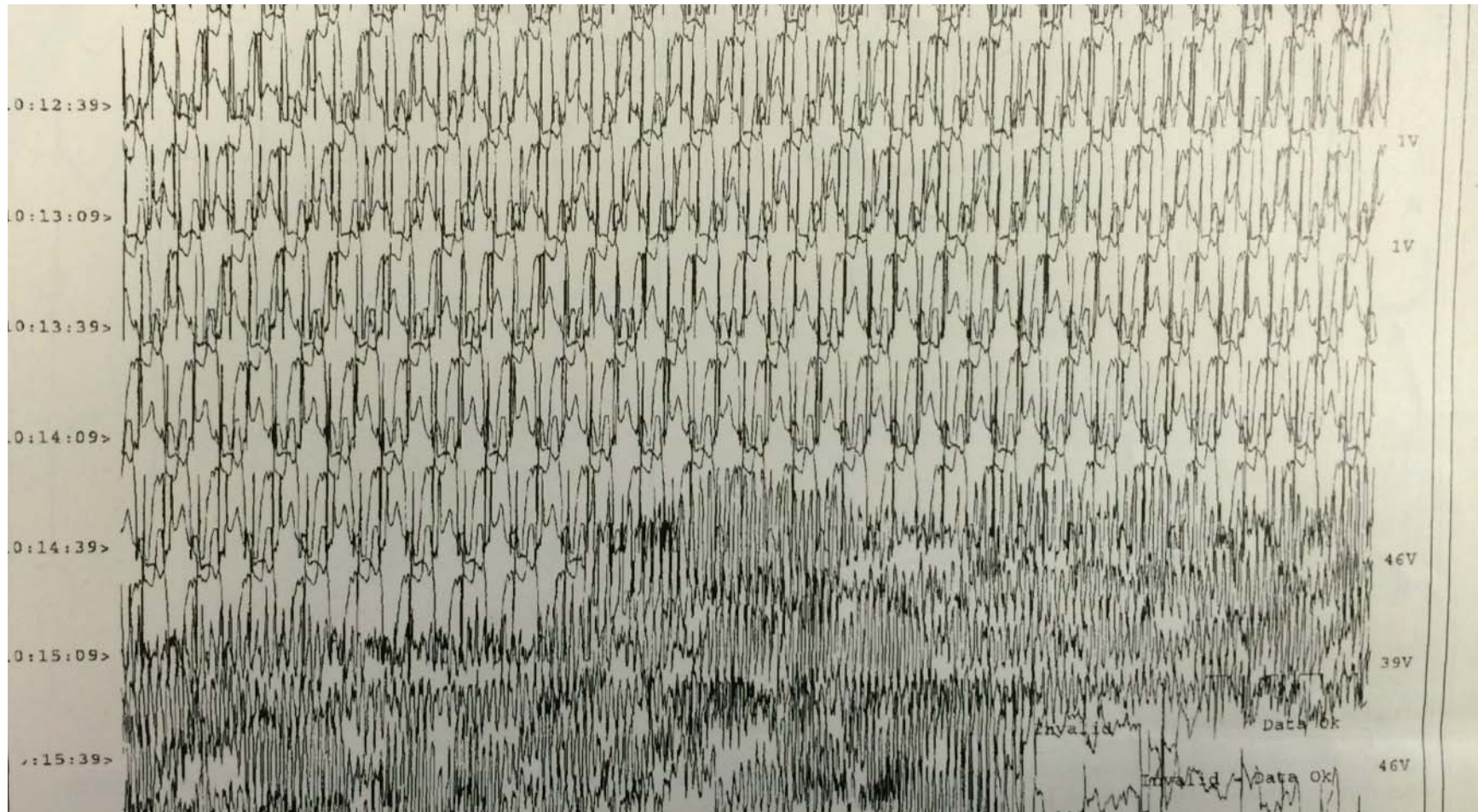
Group 6



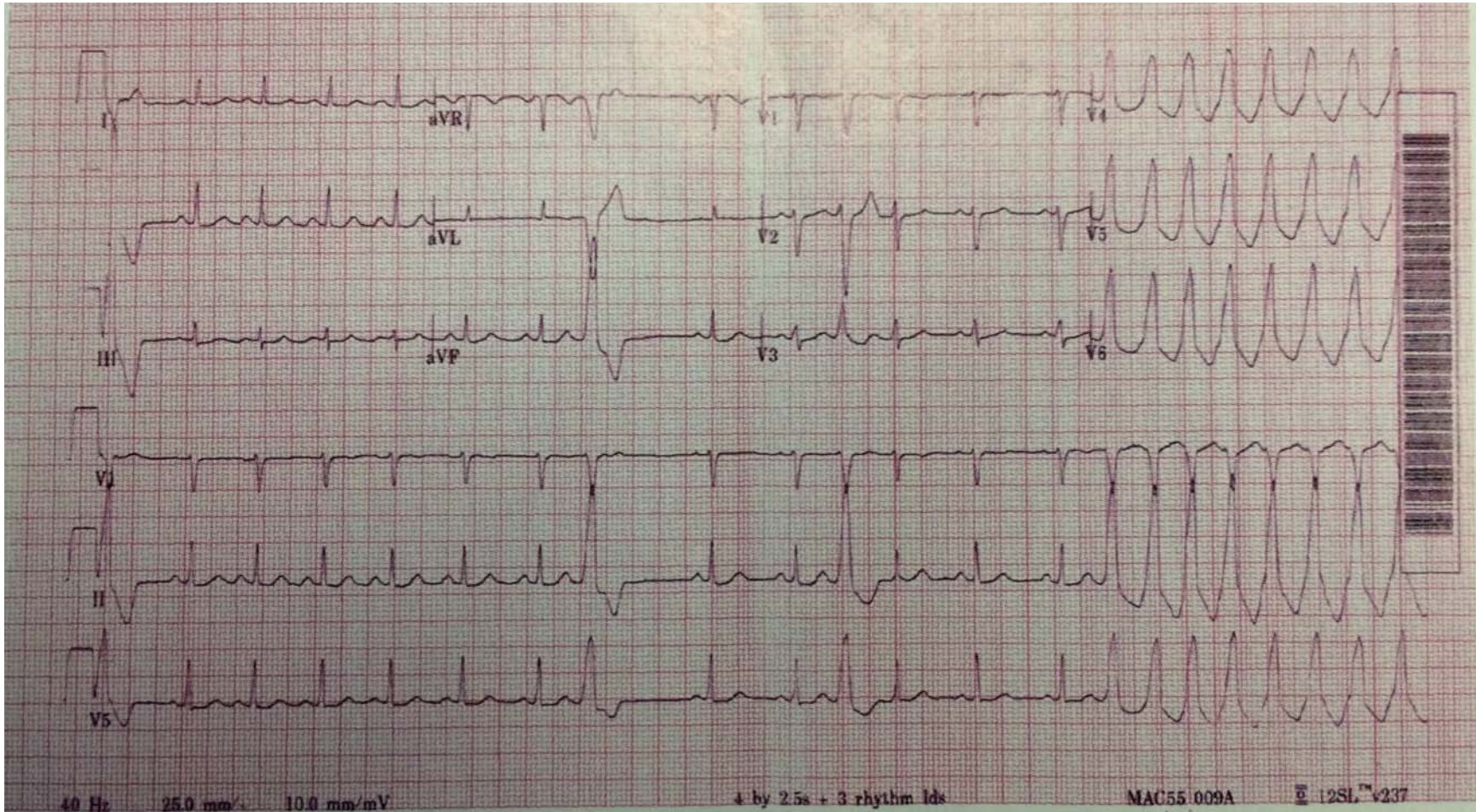
Calculating Heart Rate



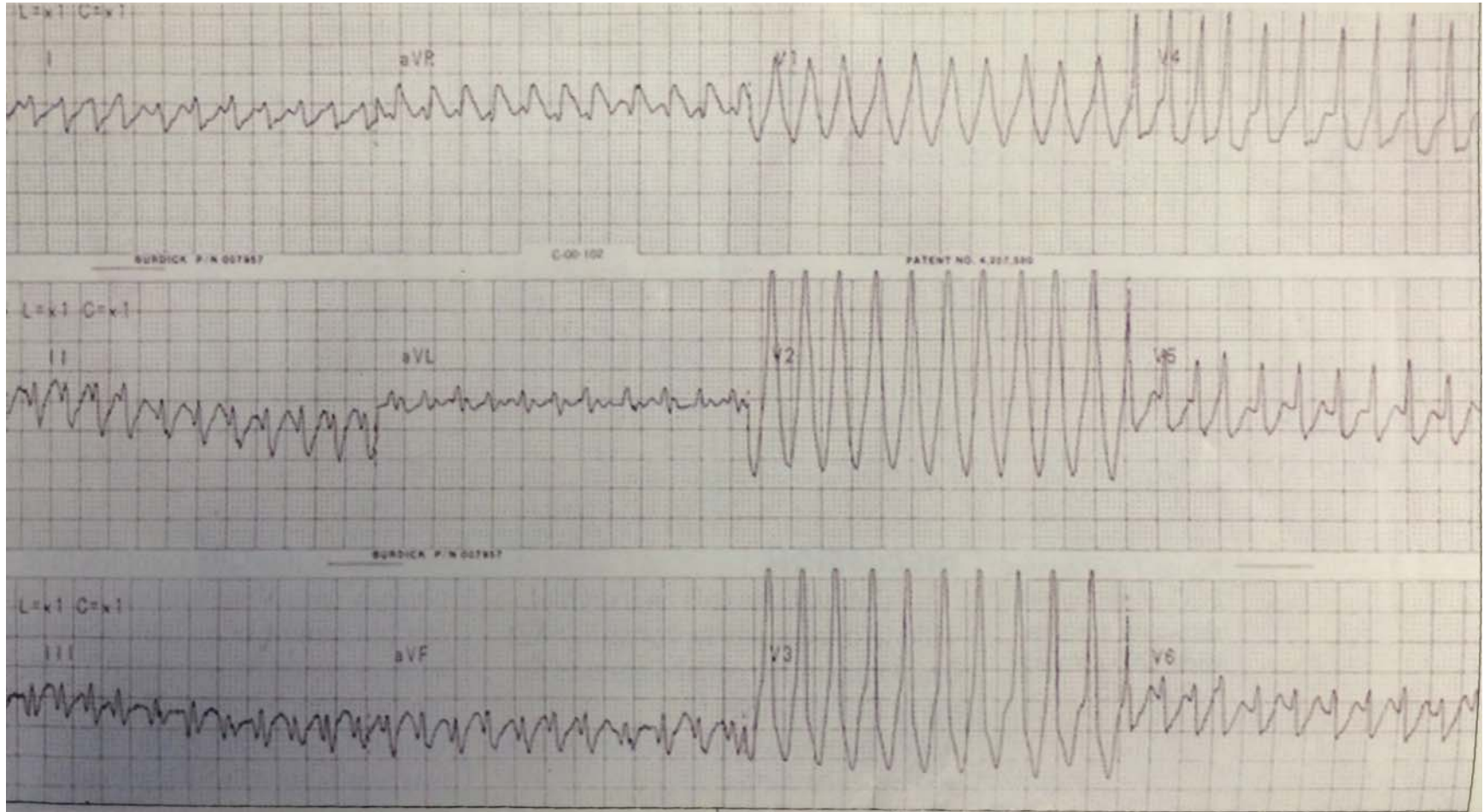
Group 6



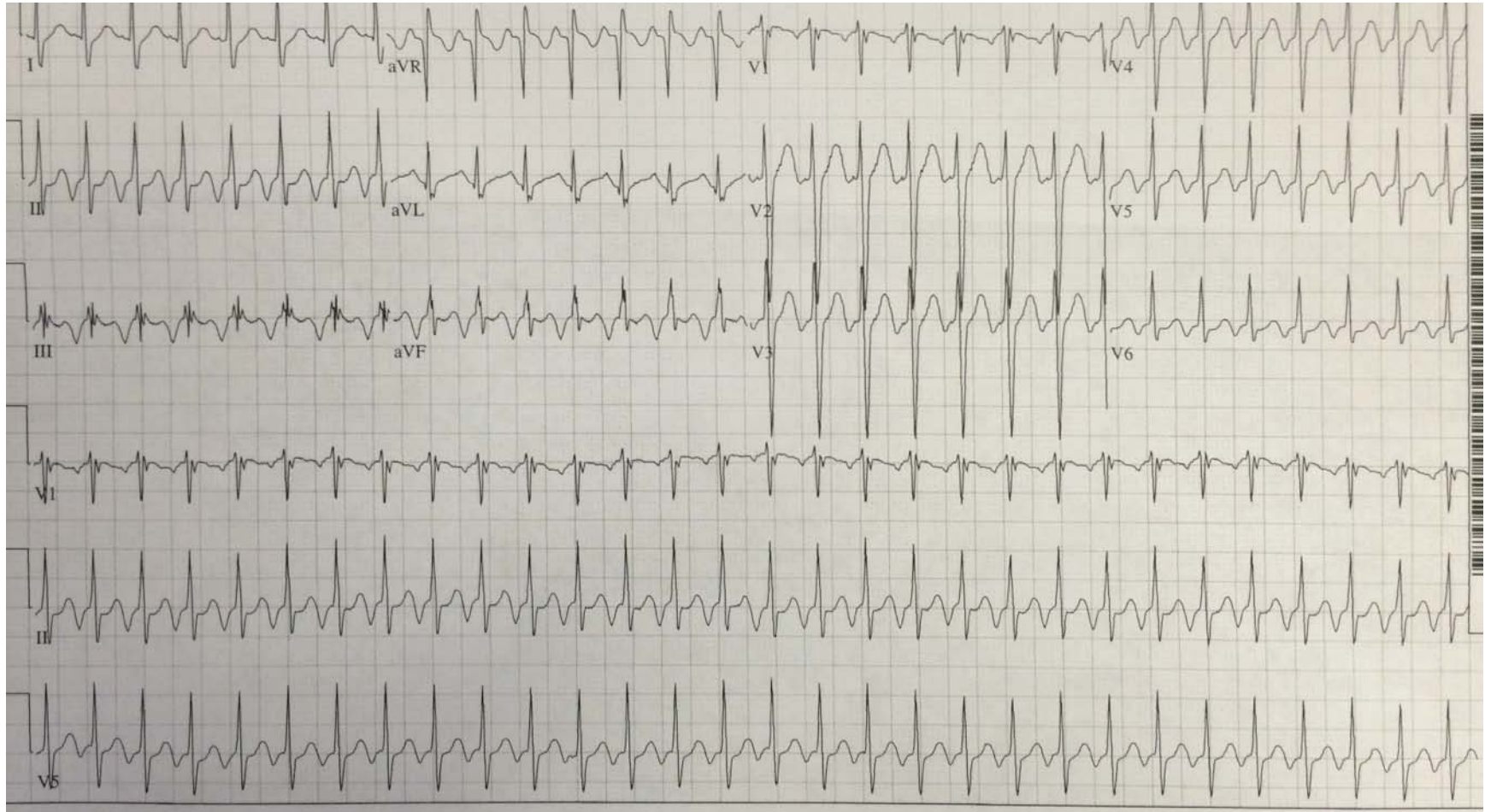
Group 6



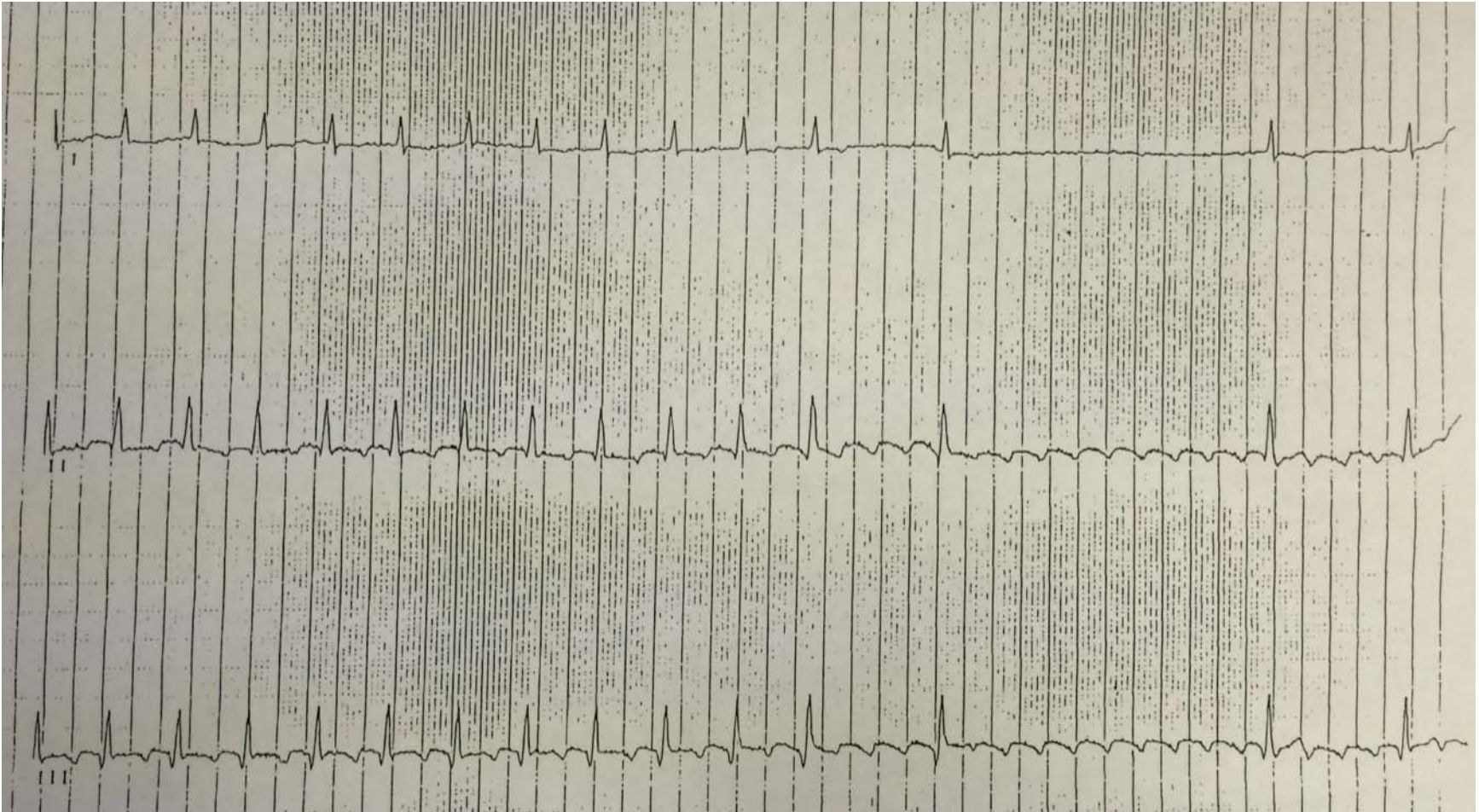
Group 6

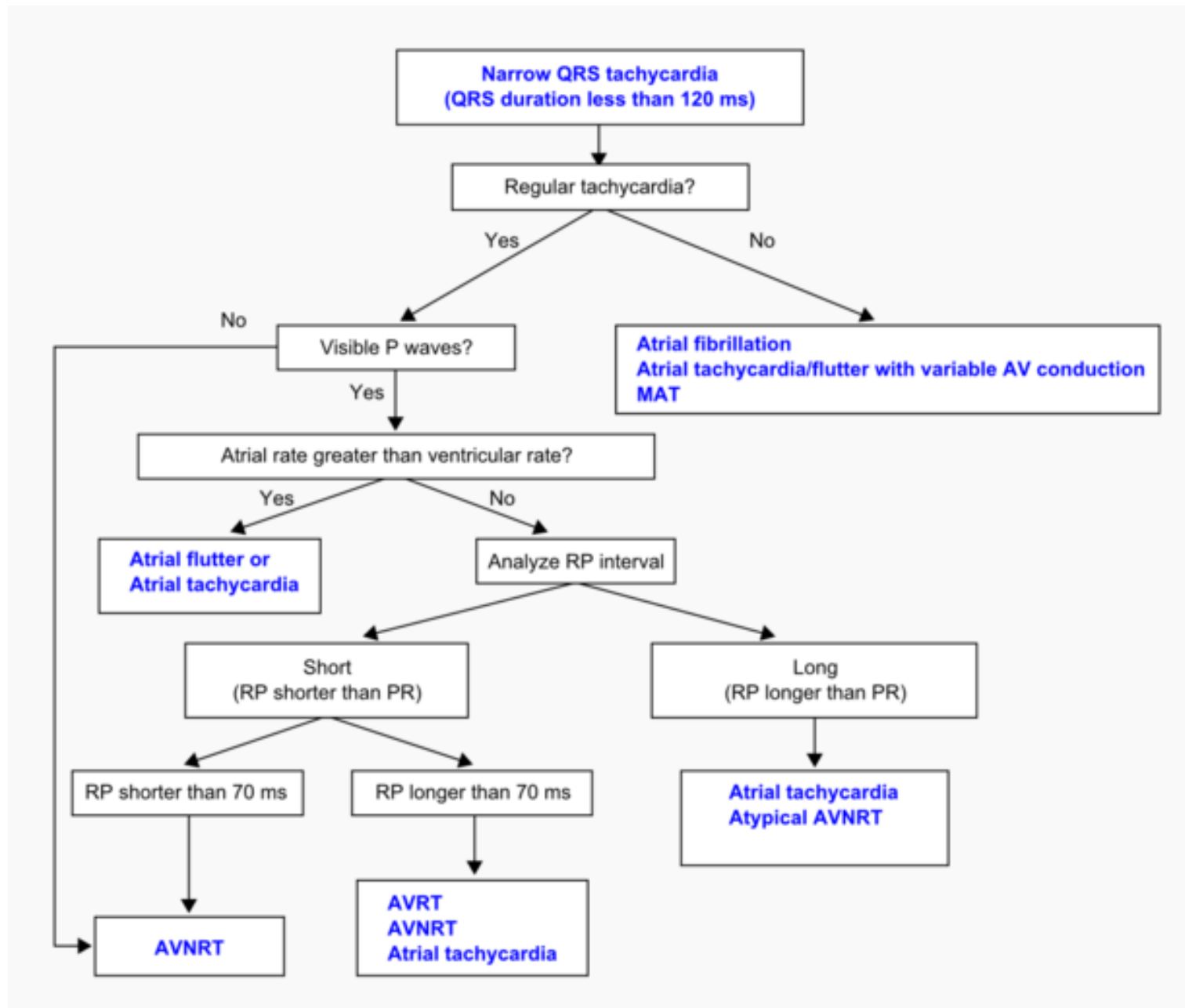


Group 6



Group 6





Group 6: Tachycardias

— Heart Rate > 100 BPM —

Narrow QRS (< 0.12 sec) - Regular R-R

- Sinus P: *Sinus tachycardia*
- Flutter waves: *Atrial flutter*
- No P: *AV nodal reentrant tachycardia (AVNRT), junctional tachycardia*
- Short R-P (R-P < 50% of R-R interval): *AVNRT, orthodromic SVT (AVRT), atrial tachycardia with 1° AV block, junctional tachycardia with 1:1 retrograde atrial activation*
- Long R-P (R-P > 50% of R-R interval): *Atrial tachycardia, sinus node reentrant tachycardia, atypical AVNRT, orthodromic SVT with prolonged V-A conduction*

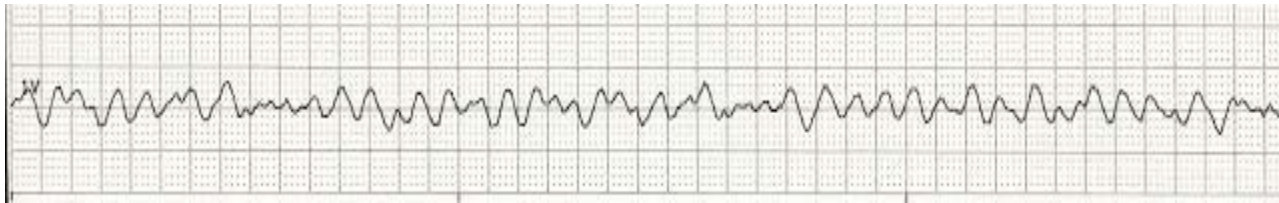
Narrow QRS - Irregular R-R

- Nonsinus P; > 3 morphologies: *Multifocal atrial tachycardia*
- Fine or coarse baseline oscillations: *Atrial fibrillation*
- Flutter waves: *Atrial flutter*
- *Any regular rhythm with 2°/3° AV block or premature beats*

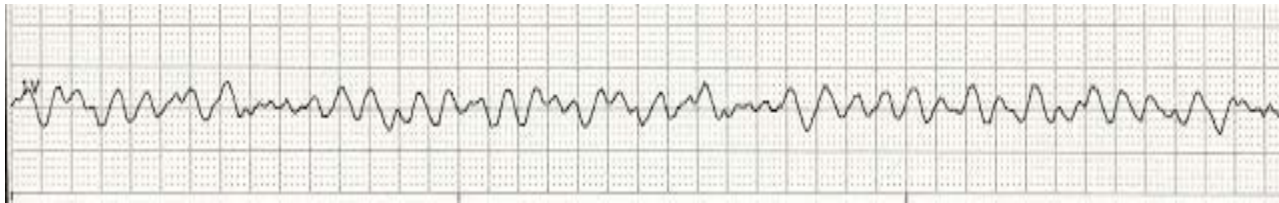
Wide QRS (≥ 0.12 seconds)

- Sinus or nonsinus P: *Any regular or irregular supraventricular rhythm with a preexisting IVCD or aberrancy*
- No P; rate 100-110: *Accelerated idioventricular rhythm*
- No P, rate 110-250: *VT, SVT with aberrancy*
- Irregular, polymorphic, alternating polarity: *Torsade de Pointes*
- Chaotic irregular oscillations; no discrete QRS: *Ventricular fibrillation*

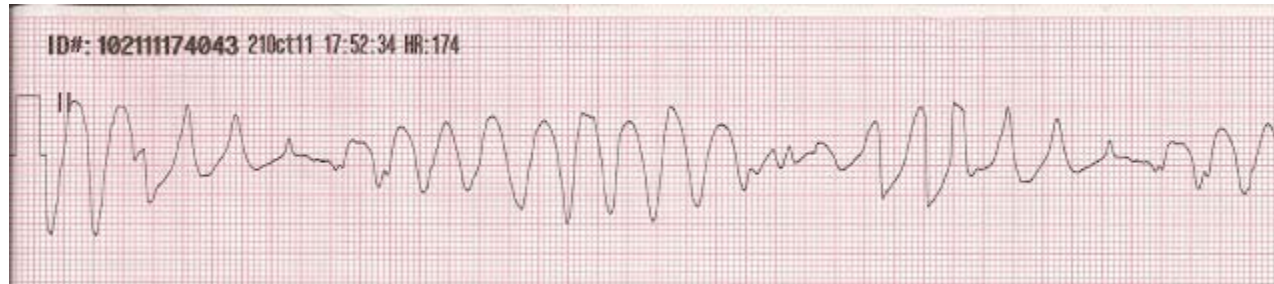
Rhythm Strip:?



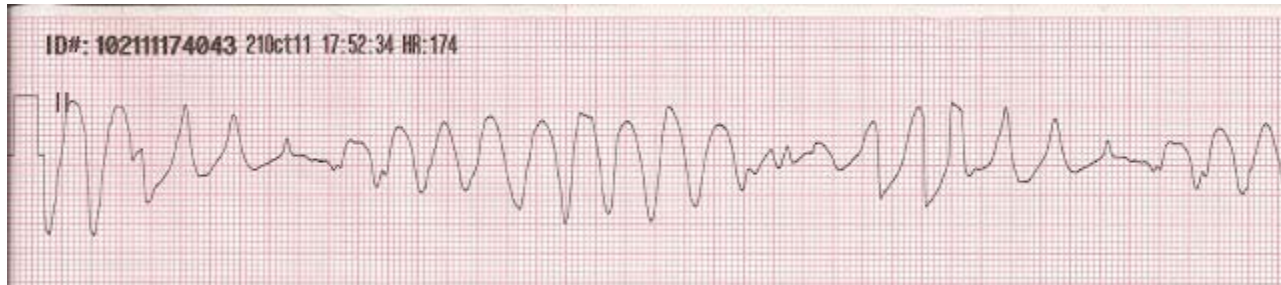
Rhythm Strip: Ventricular fibrillation



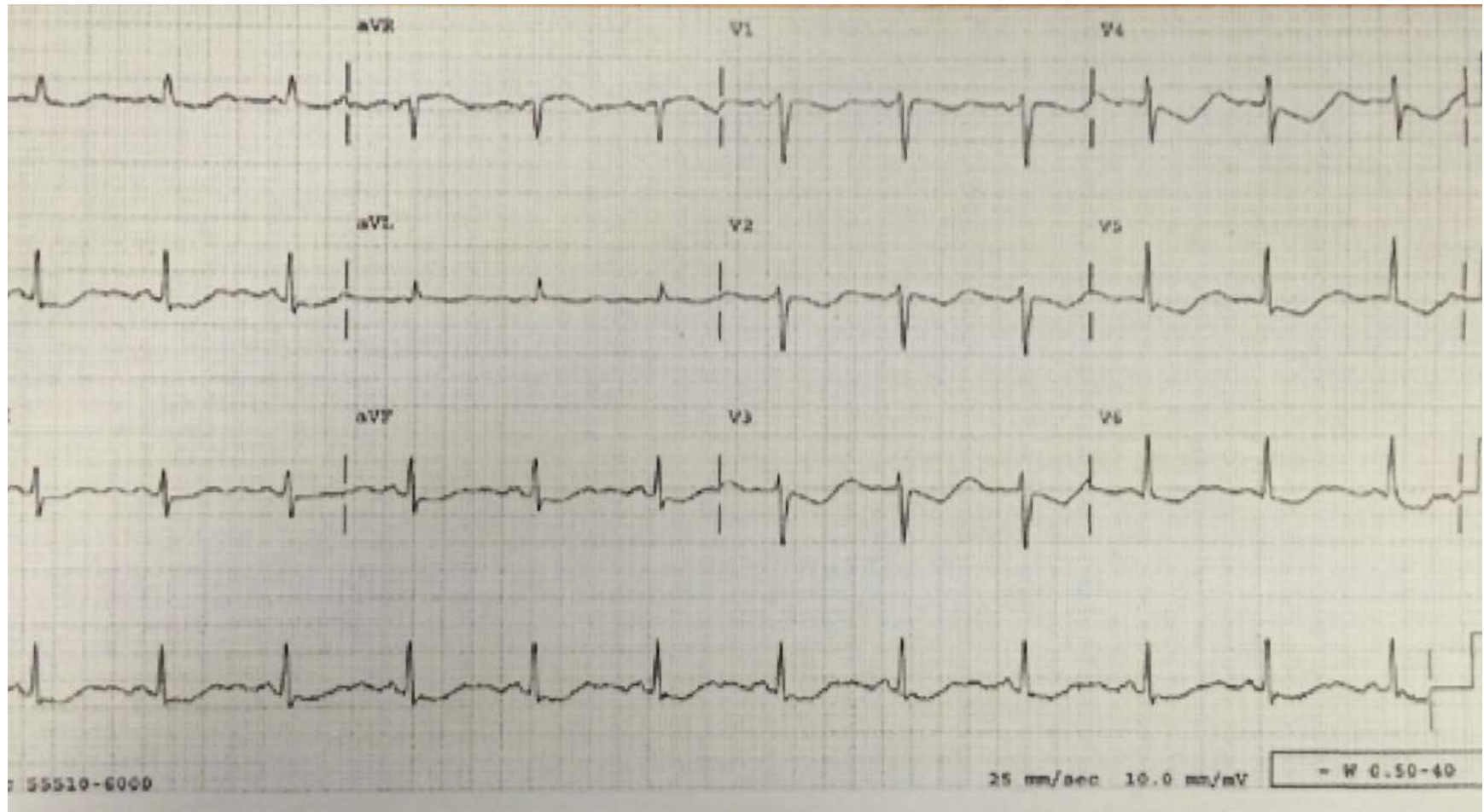
Rhythm Strip:?



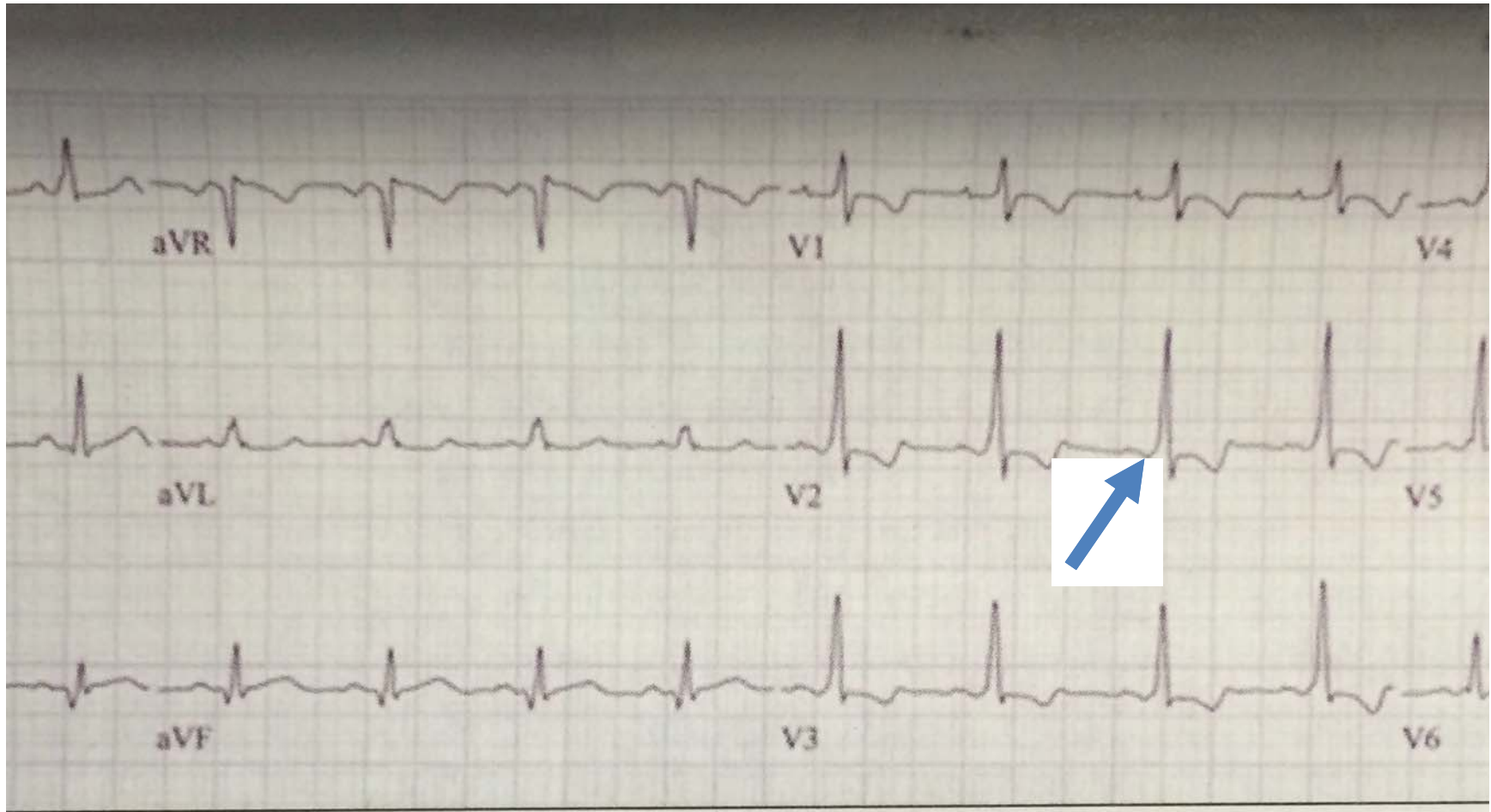
Rhythm Strip:Torsade de Pointes



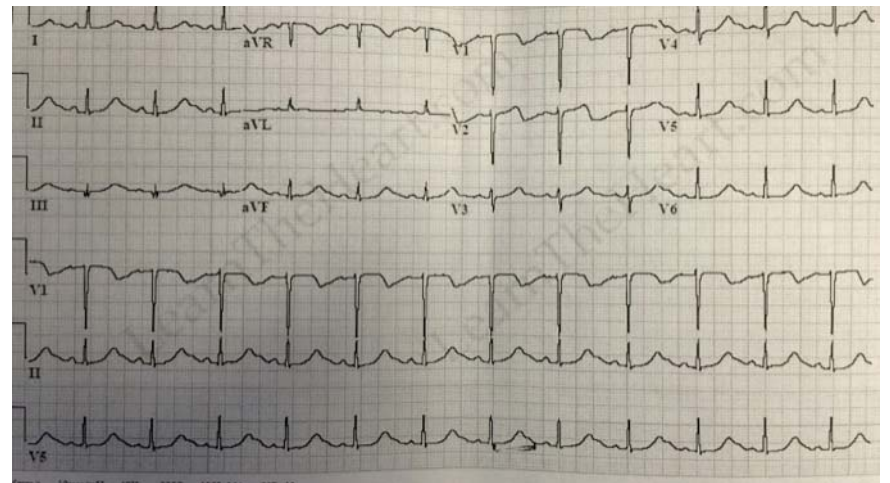
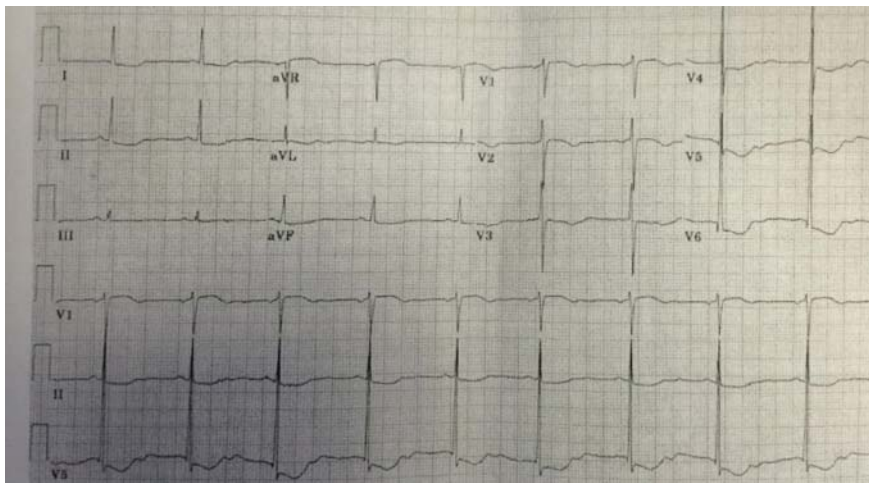
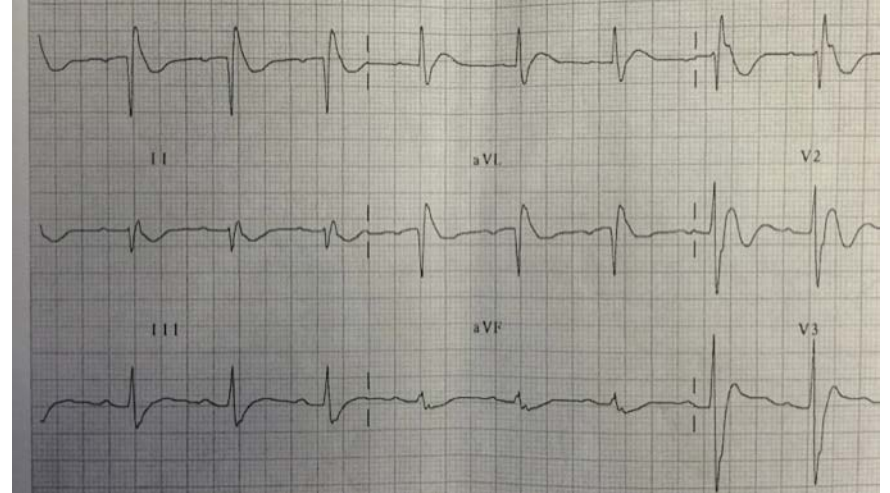
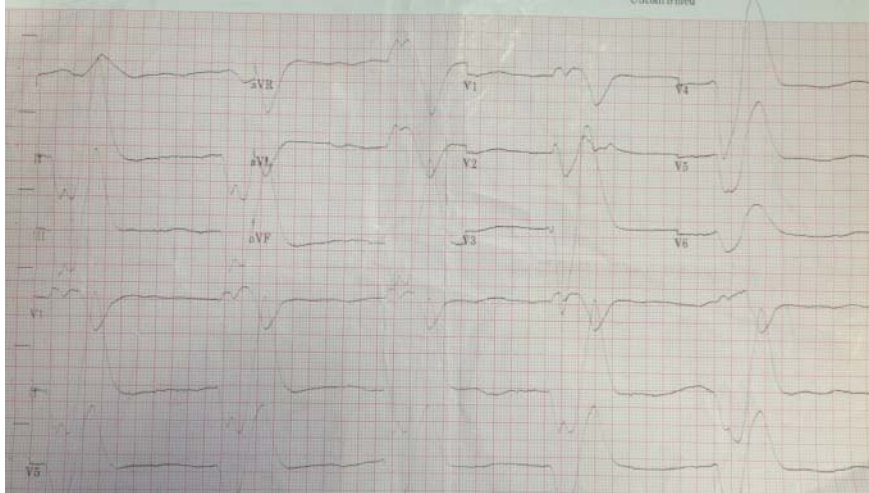
Long QT



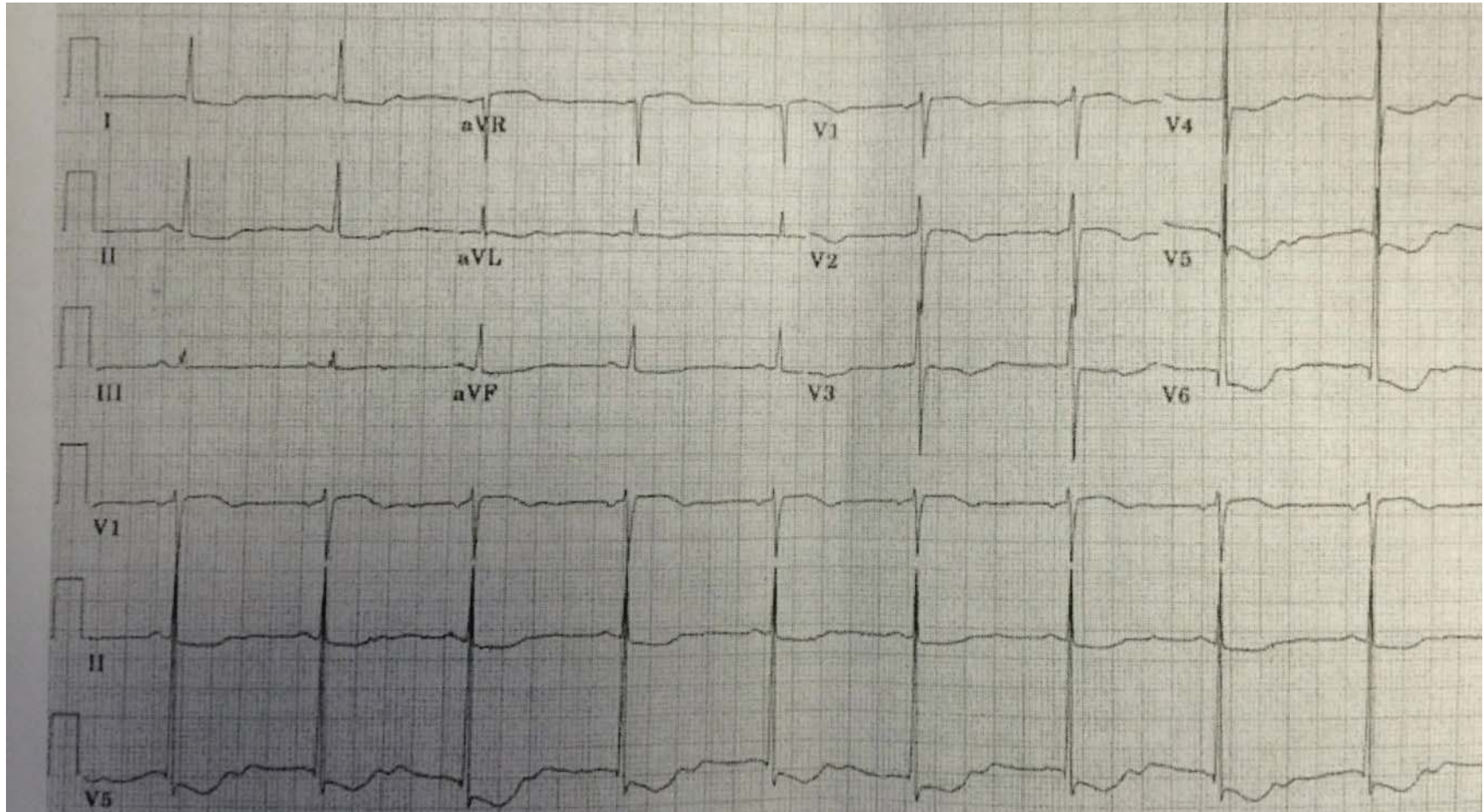
Delta Wave



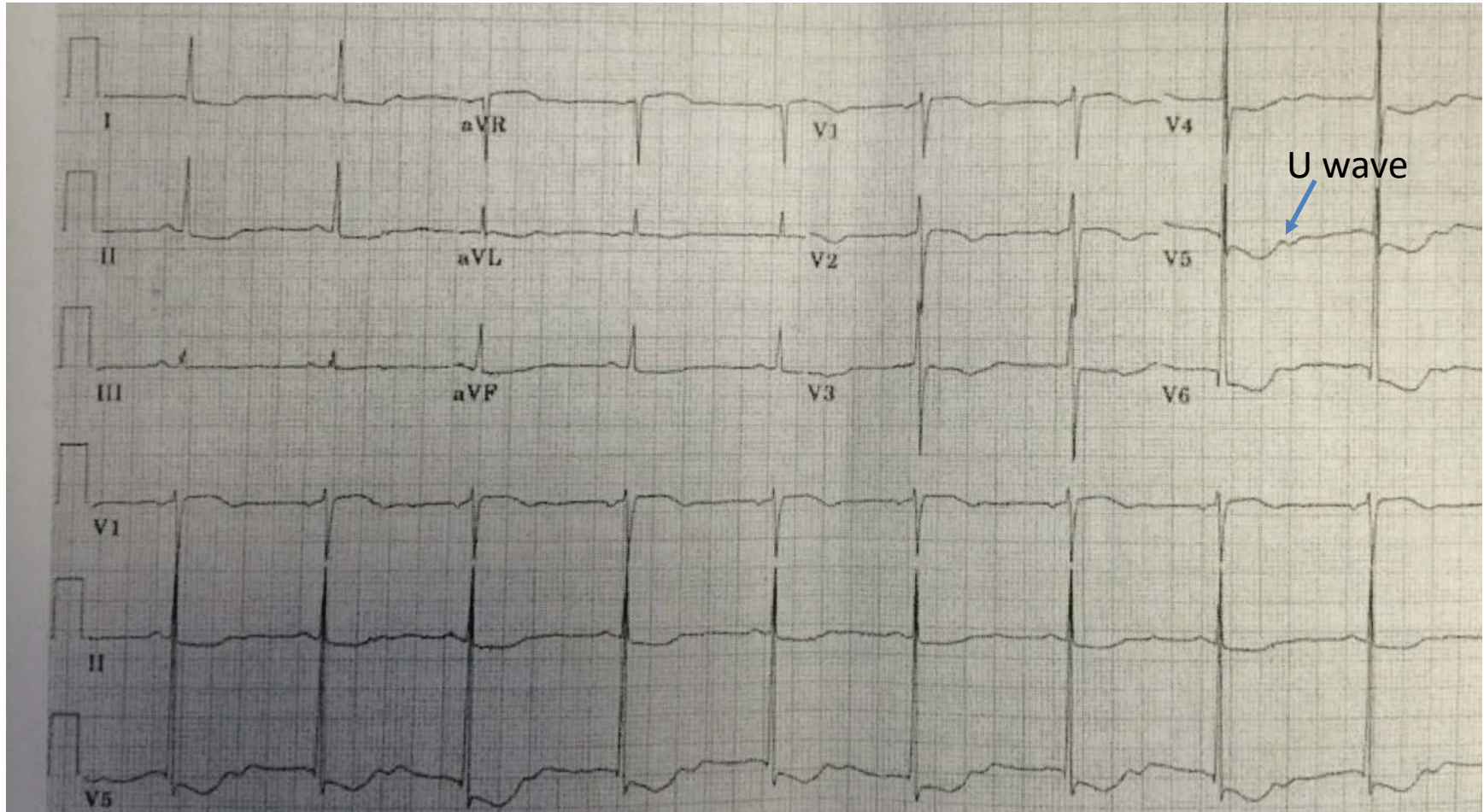
Group 7



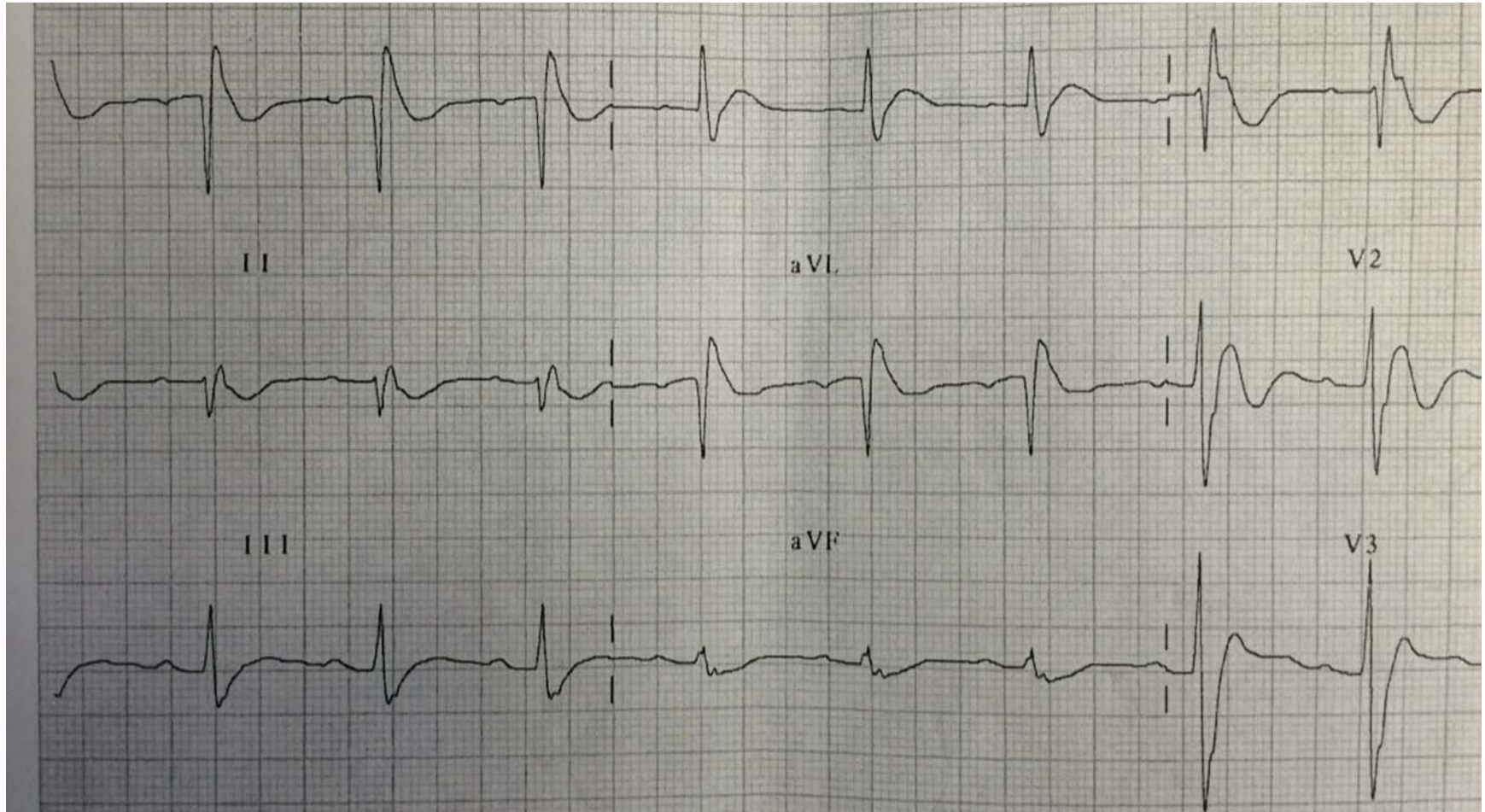
Group 7



Group 7



Group 7

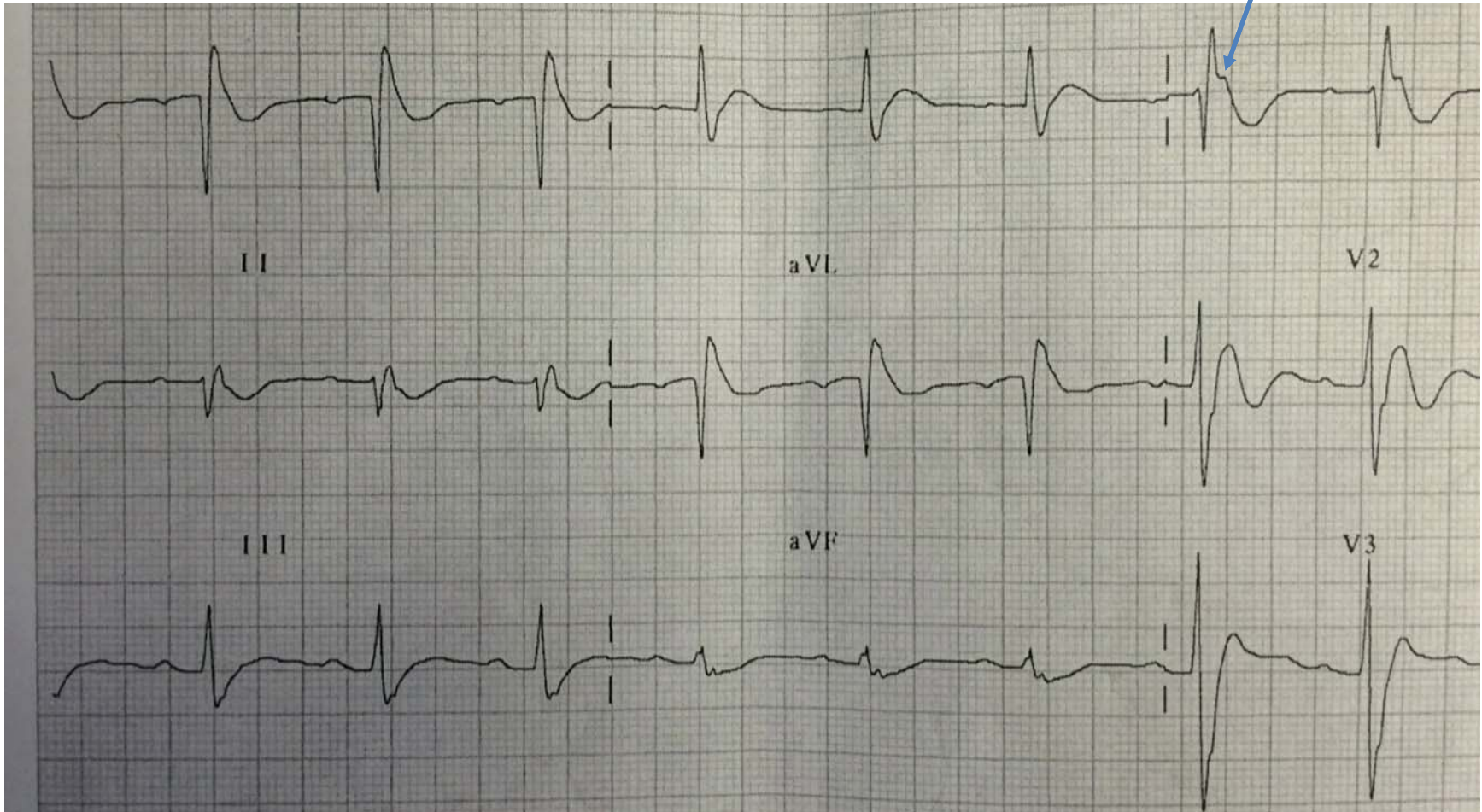


Group 7

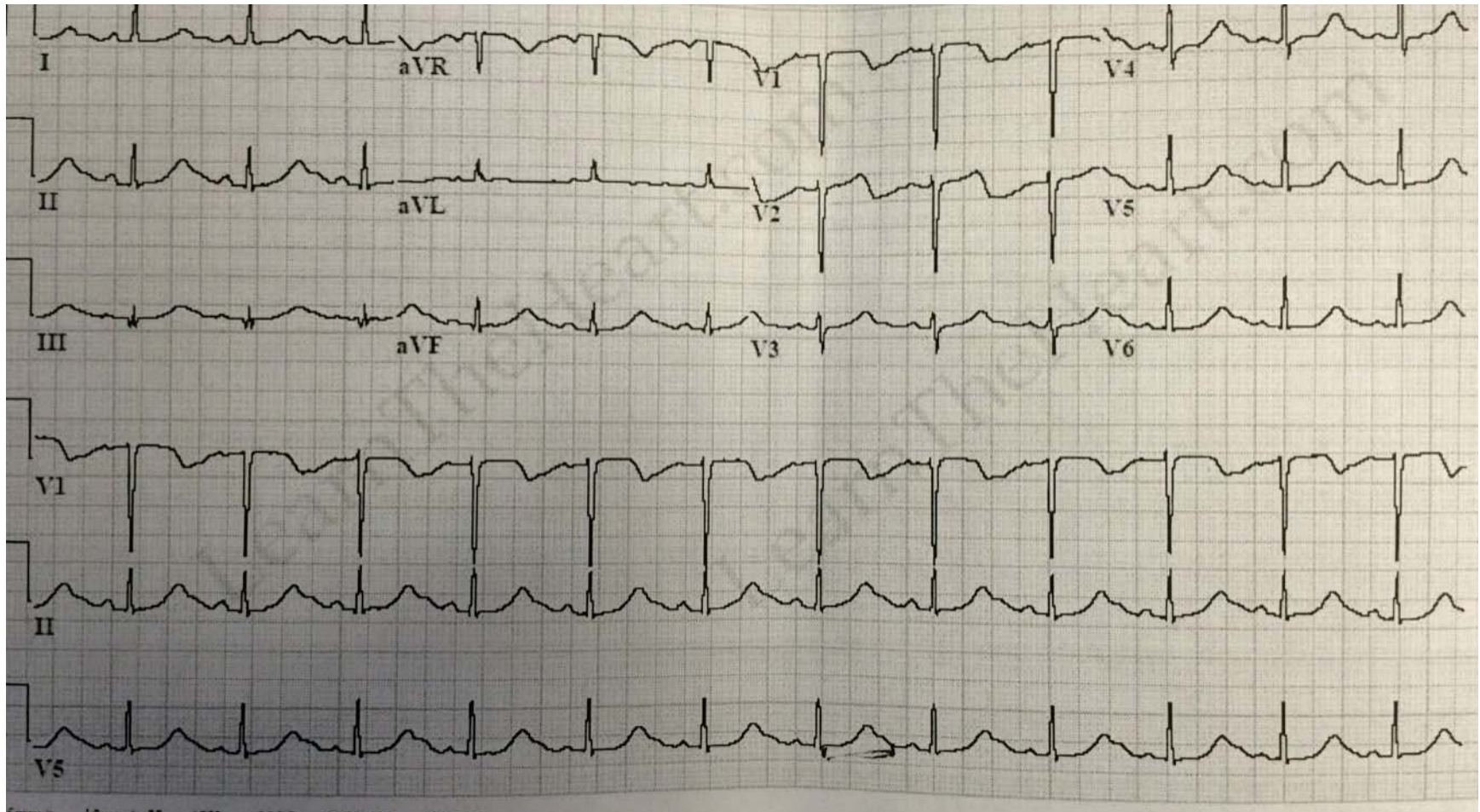
Short QT



Osborn or J wave

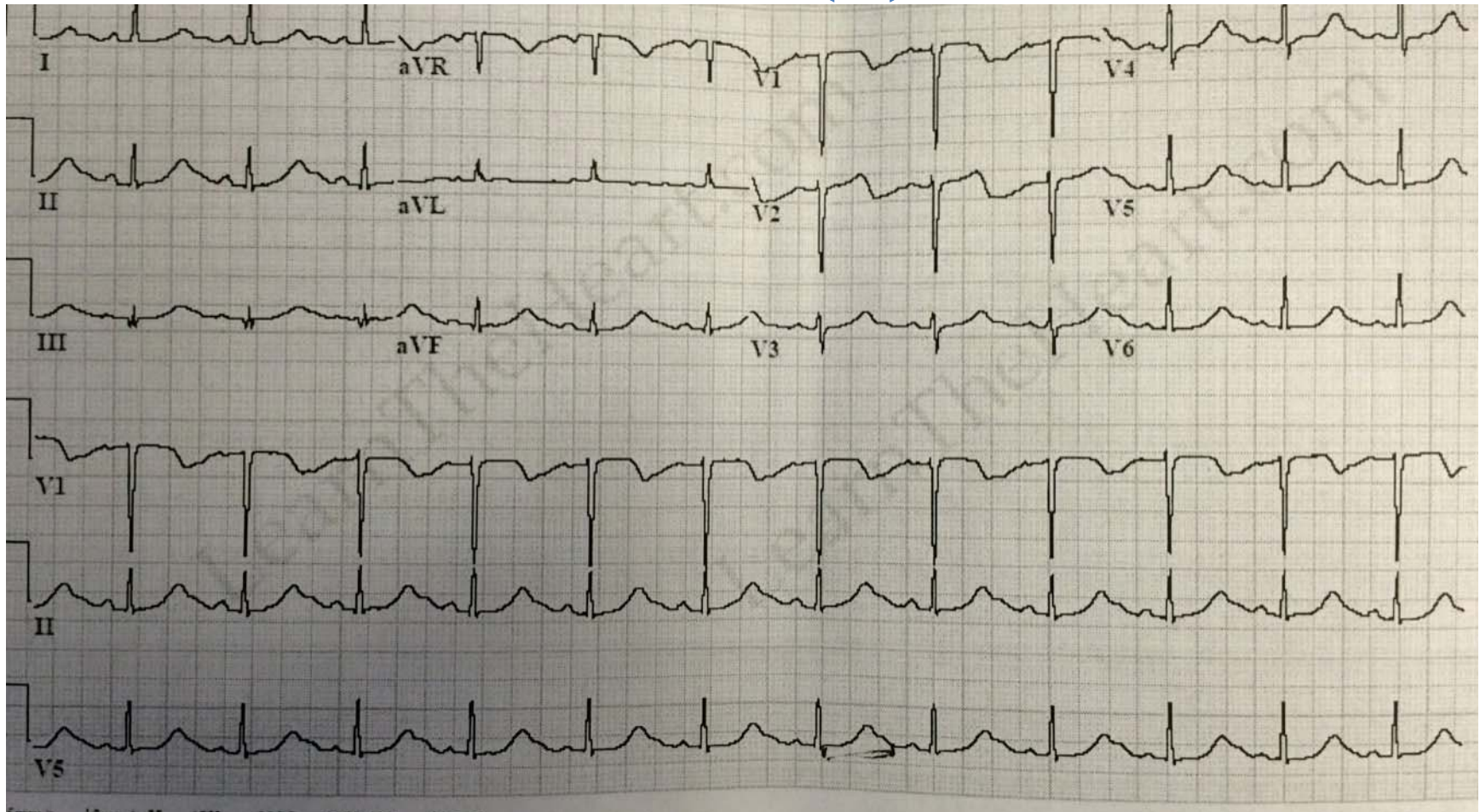


Group 7

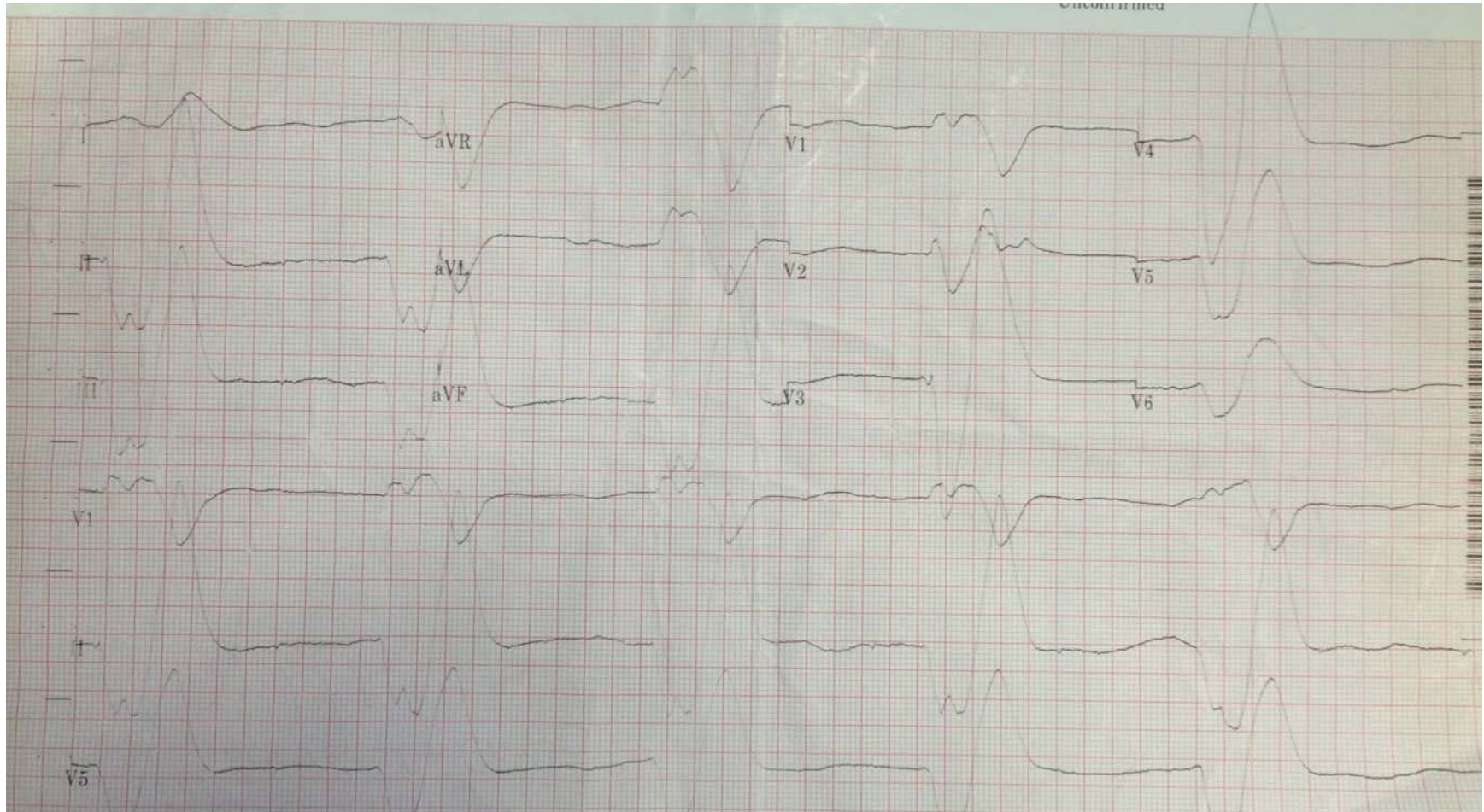


Group 7

Long QT



Group 7



Group 7: Electrolyte Abnormalities

ECG changes depend on serum K^+ level and rapidity of rise:

- $K^+ = 5.5 - 6.5 \text{ mEq/L}$
 - ▶ Tall, peaked, narrow based T waves
 - Note:** Generally defined as $> 10 \text{ mm}$ in precordial leads and $> 6 \text{ mm}$ in limb leads). May also be seen as normal variant or in acute MI, LVH, or LBBB
 - ▶ QT interval shortening
 - ▶ Reversible left anterior fascicular block (item 45) or left posterior fascicular block (item 46)
- $K^+ = 6.5 - 7.5 \text{ mEq/L}$
 - ▶ First-degree AV block (item 29)
 - ▶ Flattening and widening of the P wave
 - ▶ QRS widening
- $K^+ > 7.5 \text{ mEq/L}$
 - ▶ Disappearance of P waves, which may be caused by:
 - Sinus arrest (item 11), or
 - “Sinoventricular conduction” (sinus impulses conducted to the ventricles via specialized atrial fibers *without* atrial depolarization)
 - ▶ LBBB (items 47, 48), RBBB (items 43, 44), or markedly widened and diffuse intraventricular conduction disturbance (item 49) resembling a sine-wave pattern

75. Hypokalemia

Suggested by the following:

- Prominent U waves (item 69)
- ST segment depression and flattened T waves
- Note:** The ST-T and U wave changes of hypokalemia are seen in approximately 80% of patients with potassium levels $< 2.7 \text{ mEq/L}$, compared to 35% of patients with levels of $2.7-3.0 \text{ mEq/L}$, and 10% of patients with levels $> 3.0 \text{ mEq/L}$.
- Increased amplitude and duration of the P wave
- Prolonged QT sometimes seen
- Note:** If potassium replacement does not normalize the QT interval, suspect hypomagnesemia.
- Arrhythmias and conduction disturbances, including paroxysmal atrial tachycardia with block, first-degree AV block (item 29), Type I second-degree AV block (item 30), AV dissociation (item 35), VPCs (item 23), ventricular tachycardia (item 25), and ventricular fibrillation (item 28).

Group 7: Electrolyte Abnormalities

76. Hypercalcemia



- QTc shortening (usually due to shortening of the ST segment)
- May see PR prolongation

Note: Little if any effect on P, QRS, or T wave.

After intervention...

