Chapter 1
Electrocardiography Cases

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Abstract The electrocardiogram (ECG) is one of the most important and one or first tool for diagnosis and management of cardiovascular and sometimes systemic disorders.

Abbreviations

BAA	Biatrial abnormality
Bpm	Beat per minute
DOE	Dyspnea on exertion
Dx	Diagnosis
LAA	Left atrial abnormality
LAD	Left axis deviation
LVH	Left ventricular hypertrophy
MI	Myocardial infarction
NPJT	Non-paroxysmal junctional tachycardia
NSR	Normal sinus rhythm
PRWP	Poor R wave progression
RAA	Right atrial abnormality
RVH	Right ventricular hypertrophy

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Introduction

The electrocardiogram (ECG) is one of the most important and one or first tool for diagnosis and management of cardiovascular and sometimes systemic disorders.

Also, it can help to diagnose some abnormalities such as electrolyte abnormalities thyroid disease, hypothermia, drug effects, and systemic disease effects on the heart.

Our goal in *this* chapter is just focusing on ECG interpretation in both simple and complex cases with some comments on final diagnosis and if necessary differential diagnosis.

Electrocardiography has its greatest role in diagnosis, treatment, and follow-up the cardiac and noncardiac patients. Not only the diagnosis of abnormality is essential but it is also important to know that ECG may mimic heart disease falsely and can lead to unnecessary medical actions. The presentation and form of this chapter are directed primarily at the clinicians such as cardiologist, internist, and different cardiology fellows in echocardiography, electrophysiology, interventional cardiology, and so on.

The text consists of the case summary, illustrative case studies, interpretation of electrocardiogram, and some important point as a take-home massage.

This chapter is not a detailed presentation of the electrocardiographic manifestation and mechanism of the various ECG abnormalities. But it is intended to be familiar with common ECG abnormalities and their clinical points.

The chapter is rather aimed to be familiar with the genesis, and clinical significance of certain comment electrocardiographic and arrhythmia with focusing on their diagnosis and management.

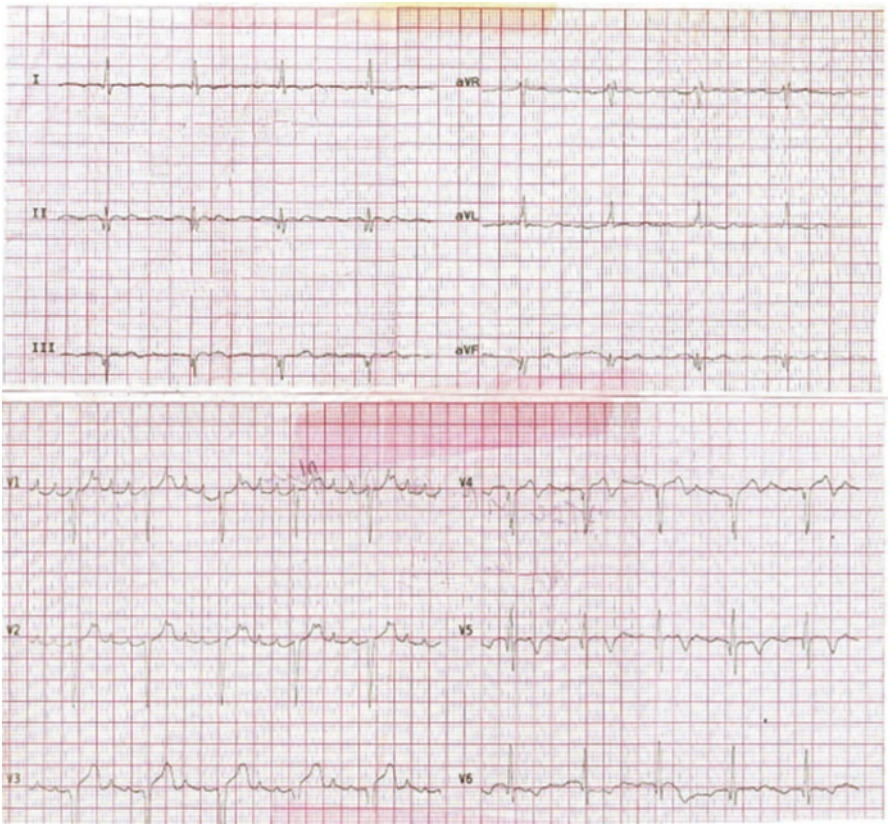
In summary, the analysis of abnormal rhythm includes three basic steps:

1. Identification and analysis of P wave in ECG
2. Finding out the P.QRS relation
3. The QRS complex analysis

If a bipolar chest leads is used for heart rhythm monitoring, then the modified CL1 (MCL1) lead is a more useful MCL1 lead that has the advantages of not interfering with cardiac physical examination and probable administration of precordial electric shock.

Case 1

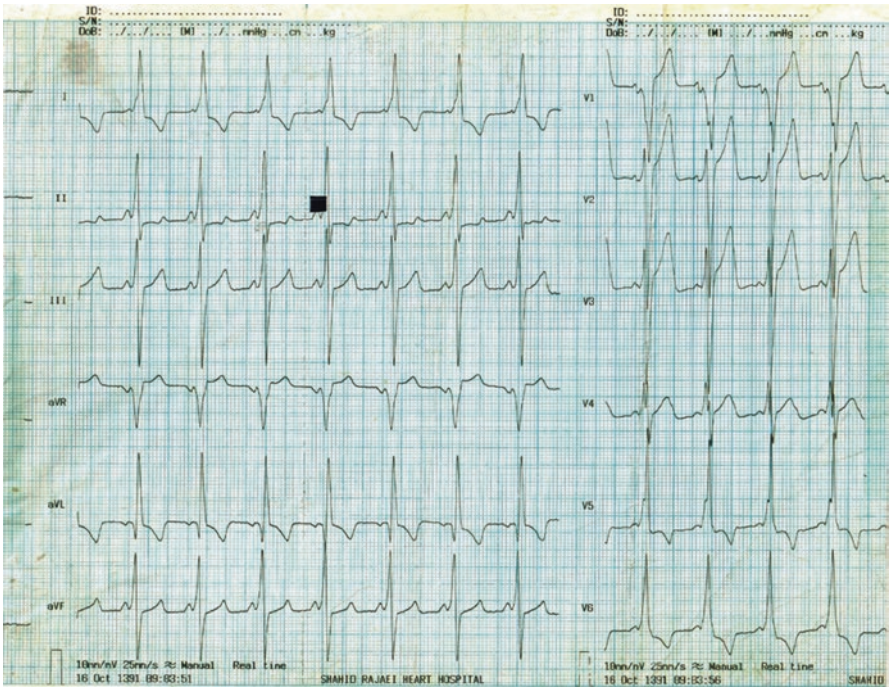
Thirty years old man with a history of mitral stenosis



- ECG: atrial flutter with 4:1 conduction
- LAD
- Atrial rate: 300 bpm
- Ventricular rate: 75 bpm
- PRwp
- Diagnosis: atrial flutter with 4:1 conduction

Case 2

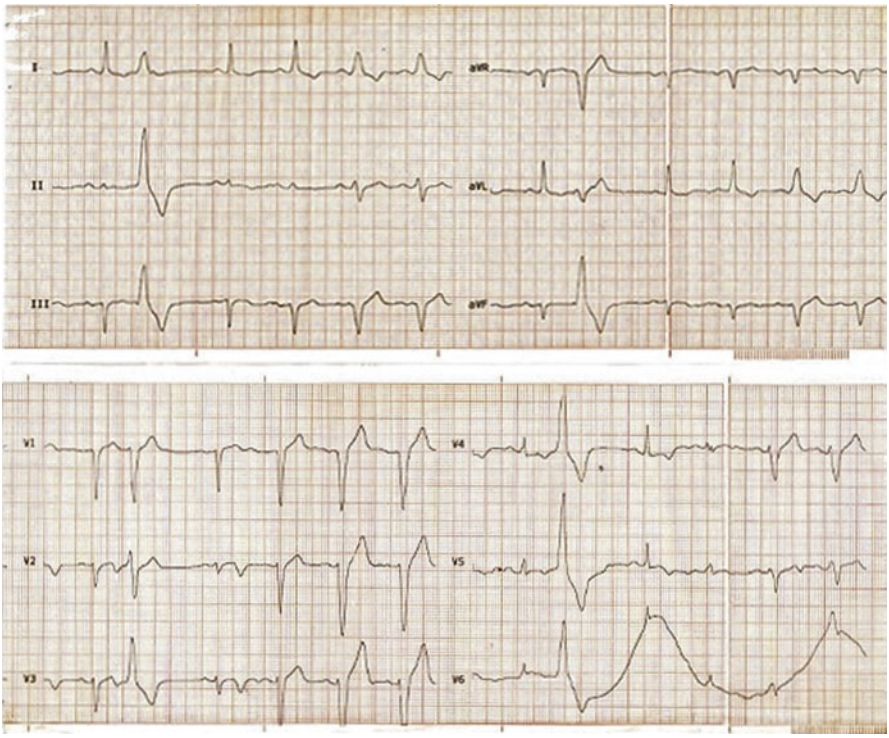
Thirty years old man with history of frequent palpitation



- ECG: NSR
- Normal axis
- 90 bpm
- Short PR interval
- Delta wave presence
- Secondary ST T changes
- Diagnosis: pre-excitation syndrome with accessory pathway probably from RV free wall [1]

Case 3

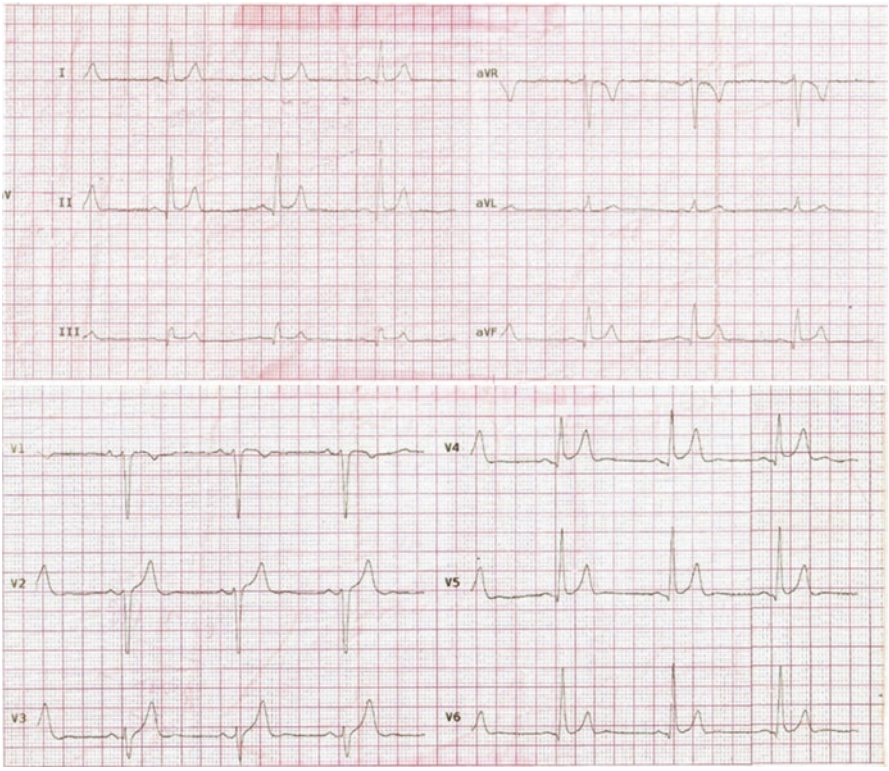
Thirty-five years old man with history of dilated cardiomyopathy since 1 year age



- ECG: NSR
- LAD
- Variable rate between 75 and 77
- Occasional PVC
- Rate-dependent LBBB with fusion beat
- Dx: occasional PVC with tachycardia dependent LBBB pattern [1]

Case 4

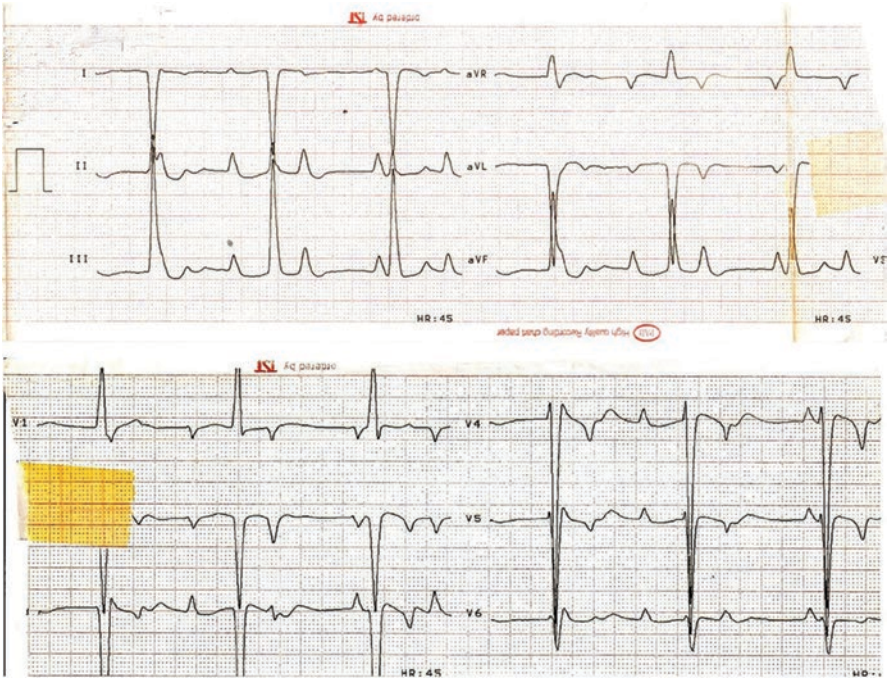
Twenty-five years healthy man with atypical chest pain



- ECG: Sinus bradycardia
- Normal axis
- Concave st elevation in inferolateral leads
- Dx: early repolarization [2]

Case 5

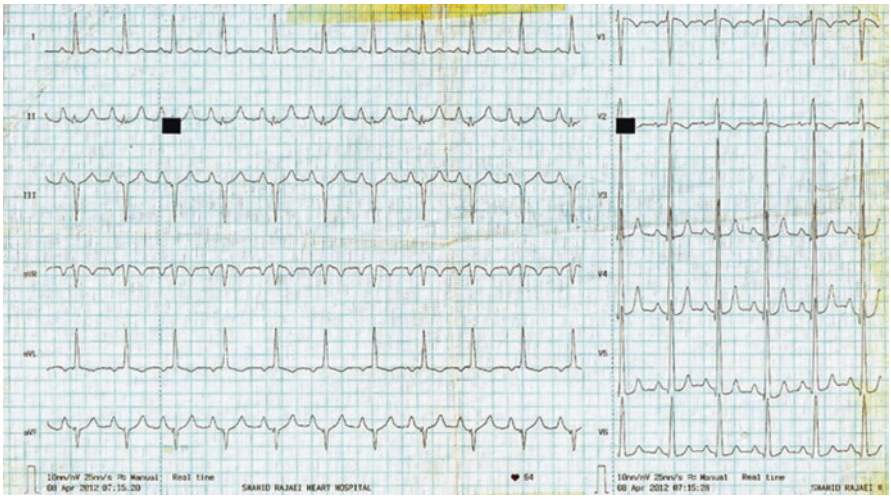
Seventy years old man with vertigo since 1 month age



- ECG: Sinus rhythm
- Atrial rate 90 bpm
- Ventricular rate 43 bpm
- AV dissociation
- Dx: complete heart block

Case 6

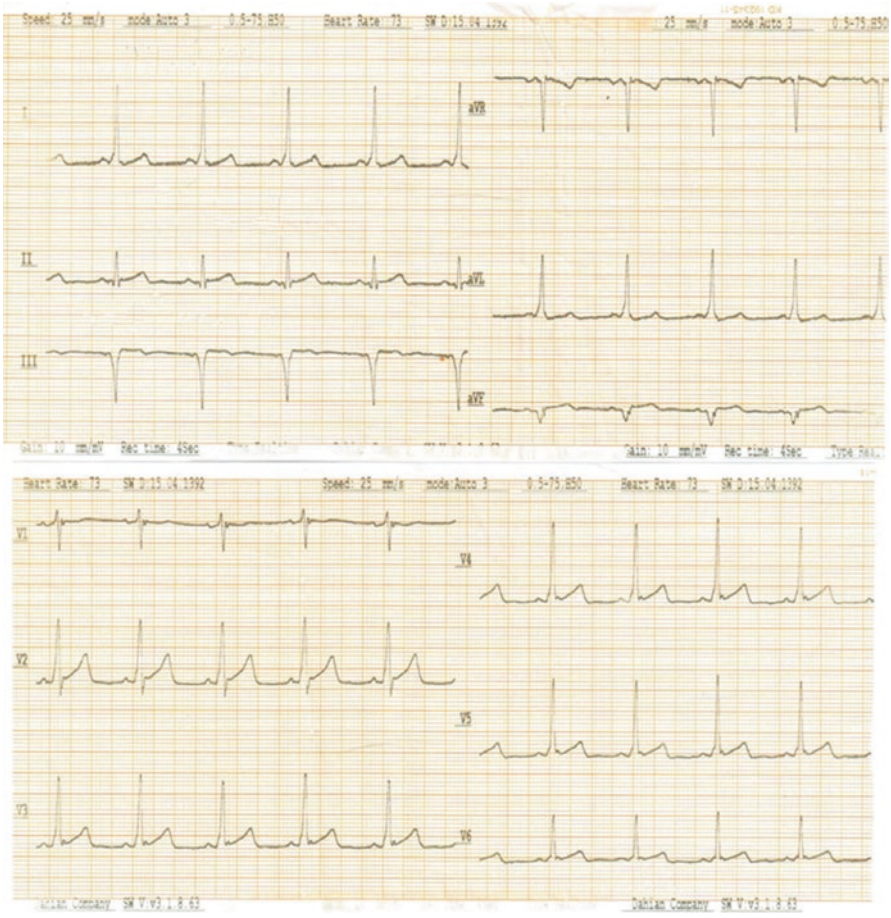
Sixteen years old girl with clubbing fingers since birth.



- ECG: NSR.
- HR 80 bpm.
- LAD.
- RAA.
- LVH.
- Dx: NSR, RAA, LVH.
- NOTE: LVH and RAA in a young cyanotic patient are strongly suggestive of Tricuspid Atresia [2].

Case 7

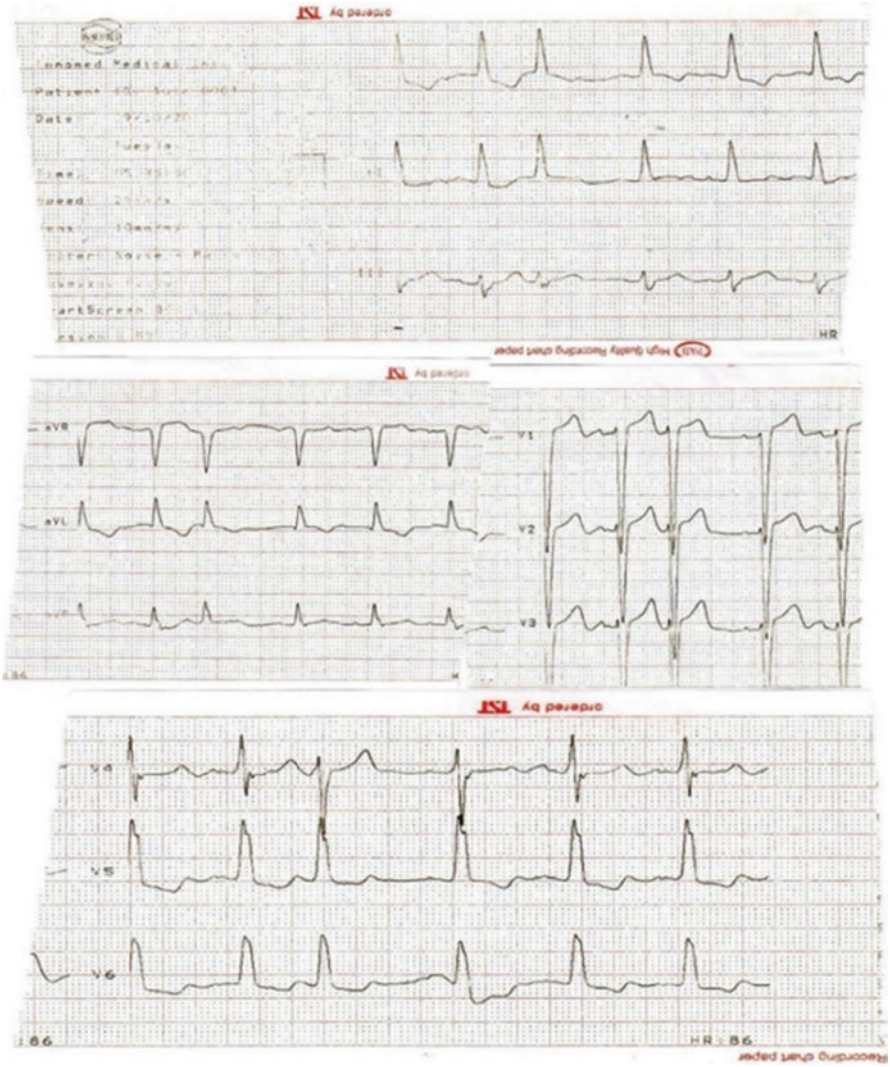
Thirty years old man with history of frequent palpitation since many years ago



- ECG: NSR
- LAD
- 75 bpm
- Short PR interval
- Delta wave
- Dx: pre-excitation syndrome with accessory pathway originated from mid-septal [3]

Case 8

Fifty years old man with history of valvular heart disease



- ECG: NSR
- Normal axis
- 75 bpm
- LBBB pattern with secondary st. T changes occasional PAC.

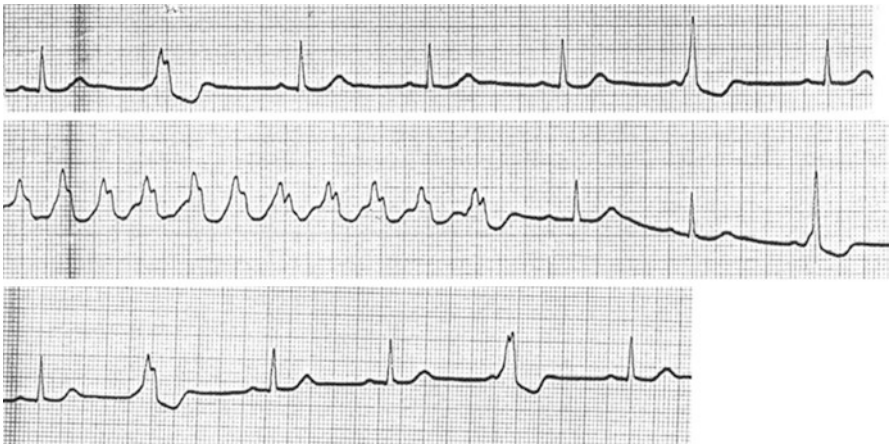
Case 9

Sixty years old man with history of valvular heart disease.

- ECG.
- AF with rapid ventricular response.
- LAD.
- Long pause, short pause with RBBB pattern (Ashman phenomenon).
- Dx: AF, LBBB pattern, with Ashman phenomenon.
- NOTE: sometimes it is difficult to distinguish PVC with RBBB pattern from aberrancy (Ashman phenomenon) in atrial fibrillation with rapid ventricular response. PVC usually has its coupling interval and compensatory and Ashman phenomenon is distinguished in AF with preceding long pause short pause with RBBB pattern [2].

Case 10

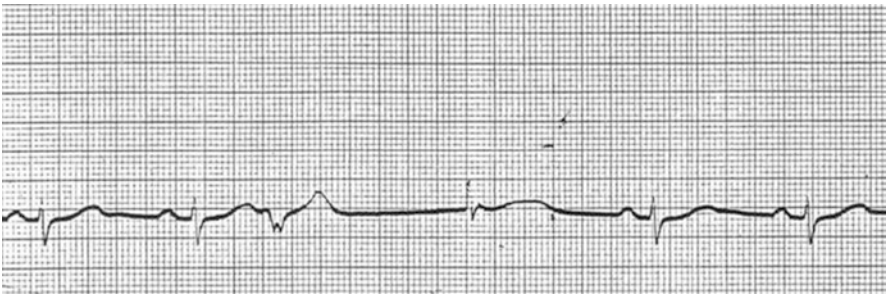
Sixty years old man with history of CABGS 1 week ago.



- ECG: Lead II.
- Sinus rhythm.
- PVC (second beat in the first row).
- Fusion beat (sixth beat in the first row).
- Short run of ventricular tachycardia with concealed conduction to AV node and subsequent prolonged PR interval after VT [3].

Case 11

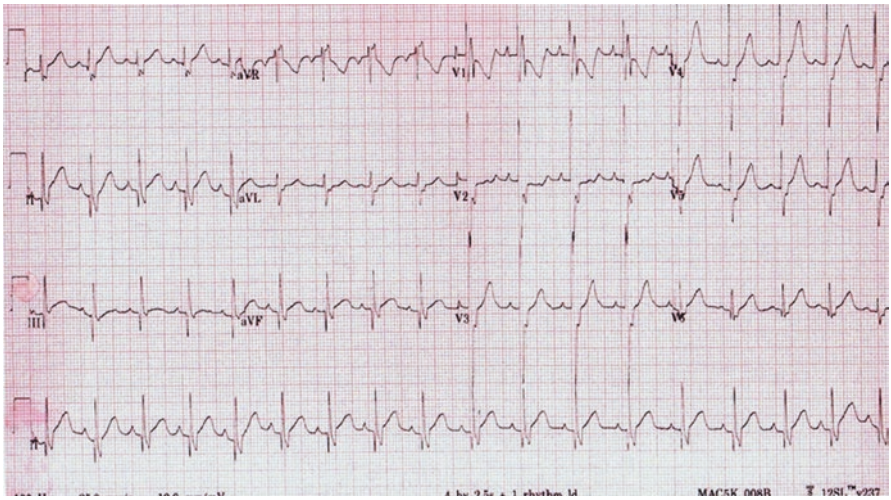
Thirty-eight years old lady with history of Rheumatic heart disease.



- ECG: Sinus rhythm.
- PVC with compensatory pause junctional escape beat after PVC.
- NOTE: sinus node in patient with sick sinus syndrome may not recover after a compensatory pause with pvc and unusual recovery of the sinus node is suggestive of sinus node disease.

Case 12

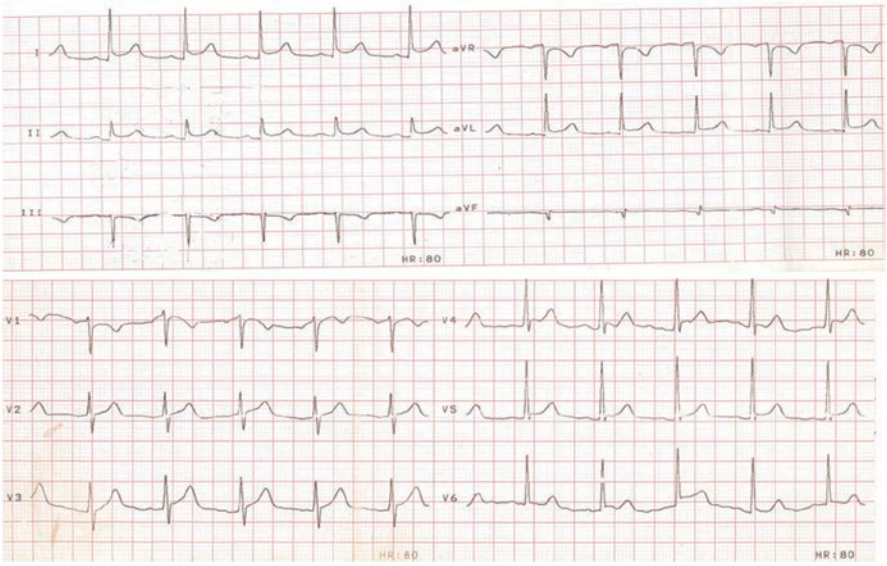
Sixteen years old asymptomatic boy with III/VI murmur at lower left sternal border and sail sound due to Ebstein anomaly.



- ECG.
- NSR.
- RAD.
- HR: 100/min.
- RAA.
- RBBB, rsr'.
- Fragmented QRS in V.
- Note: This ECG pattern and Fragmented QRS may be due to atrialization of parts of the right ventricle. Fragmented QRS in right precordial leads may be due to abnormal depolarization of residual right ventricle [2].

Case 13

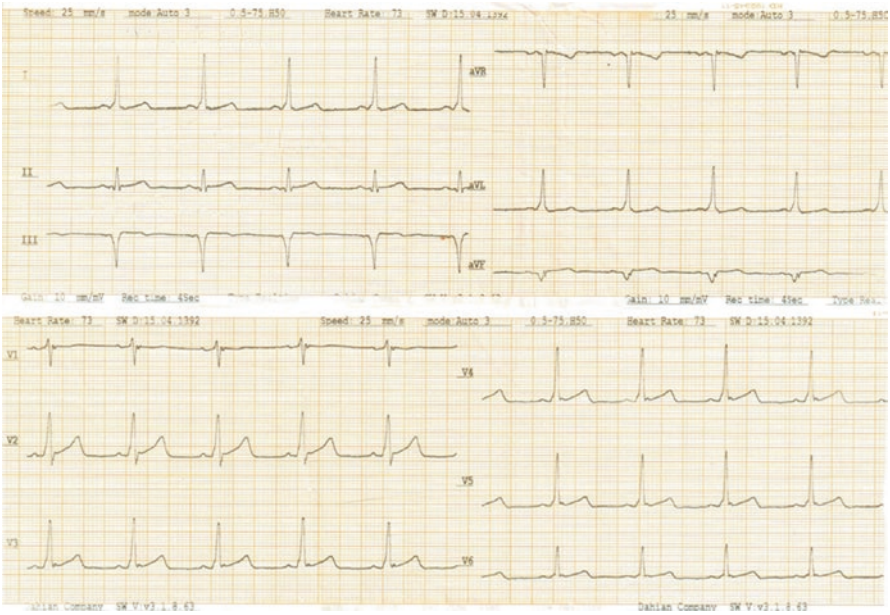
Thirty years old man with chest pain aggravation by respiration since 1 week ago. He had history of influenza 20 weeks ago.



- ECG.
- NSR.
- HR: 80/min.
- LAD.
- ST. elevation in all leads except AVR and V1.
- ST Depression in AVR and V1.
- Note concave st. Elevation in all except AVR and V1 which in characteristics for pericarditis [2].

Case 14

Twenty-three years old man with history of frequent palpitation



- ECG: NSR
- 75/min
- LAD
- Short PR
- Delta wave
- Tall R in V1-V2
- Diagnosis pre-excitation syndrome (WPV)

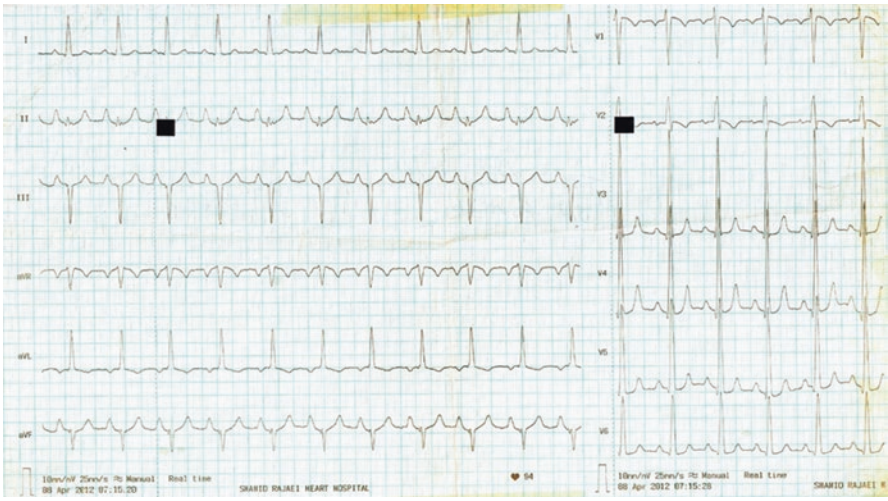
Case 15

Fifty years old man with history of myocardial infarction and congestive heart failure. Echocardiography showed enlarged cardiac chambers and reduced Ejection fraction.

- ECG: Narrow QRS regular rhythm.
- 75/min.
- Q wave in II, III, AVF.
- ST.t change in, AVL, v4-v6.
- QS pattern in precordial leads with inverted T wave in v4-v6.
- Atrial rate 300/min.
- Ventricular rate 75/min.
- Diagnosis, Atrial flutter with 4:1 conduction, old inferior myocardial infarction [4].

Case 16

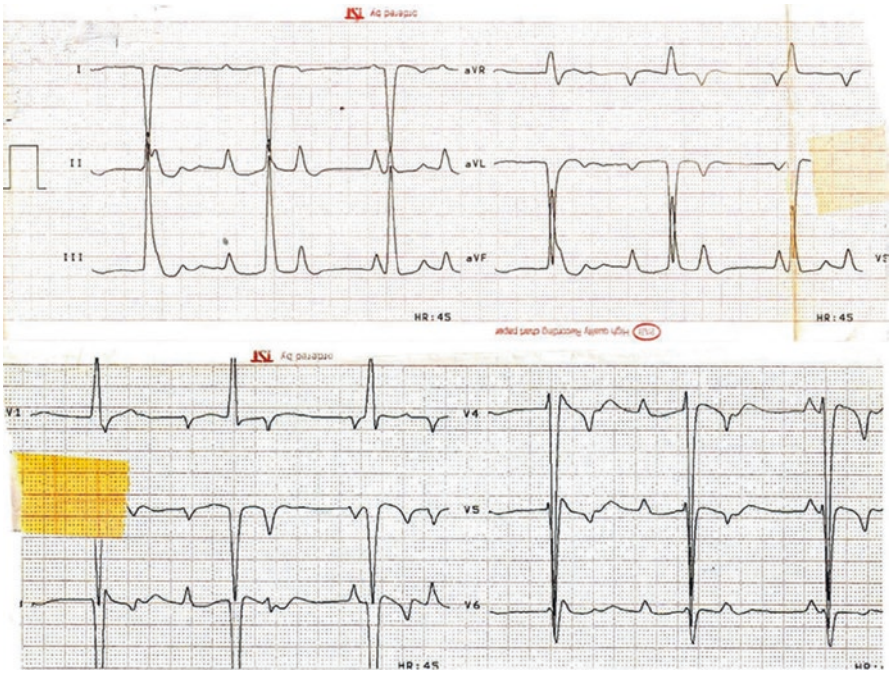
Twenty years old cyanotic man with dyspnea on exertion (Fc, II, III) since childhood.



- ECG.
- NSR.
- HR: 100/min.
- LAD.
- RAA.
- High voltage QRS in the precordial lead.
- Diagnosis, RAA, LVH most probably due to Tricuspid Atresia.
- Sometimes thin pattern is seen in a single ventricle too [2].

Case 17

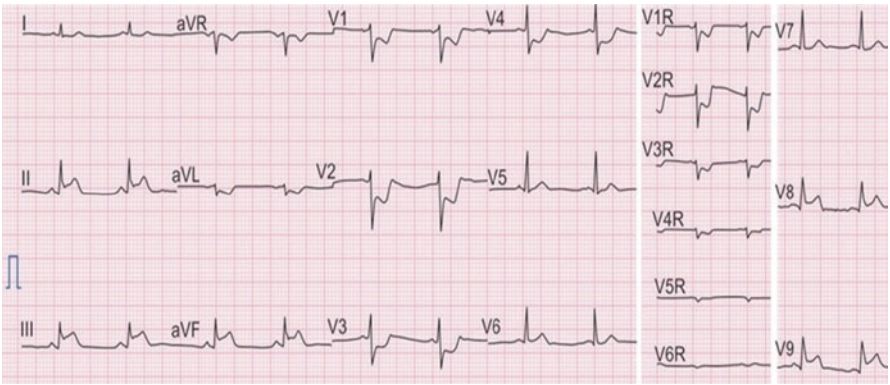
Seventy years old woman with vertigo since last week.



- ECG: Atrial rate 75/min.
- Ventricular rate 48/min.
- AV Dissociation.
- Complete heart block.
- Note: complete heart block usually is Av dissociation too but AV dissociation in not always complete heart block such as ventricular tachycardia.

Case 18

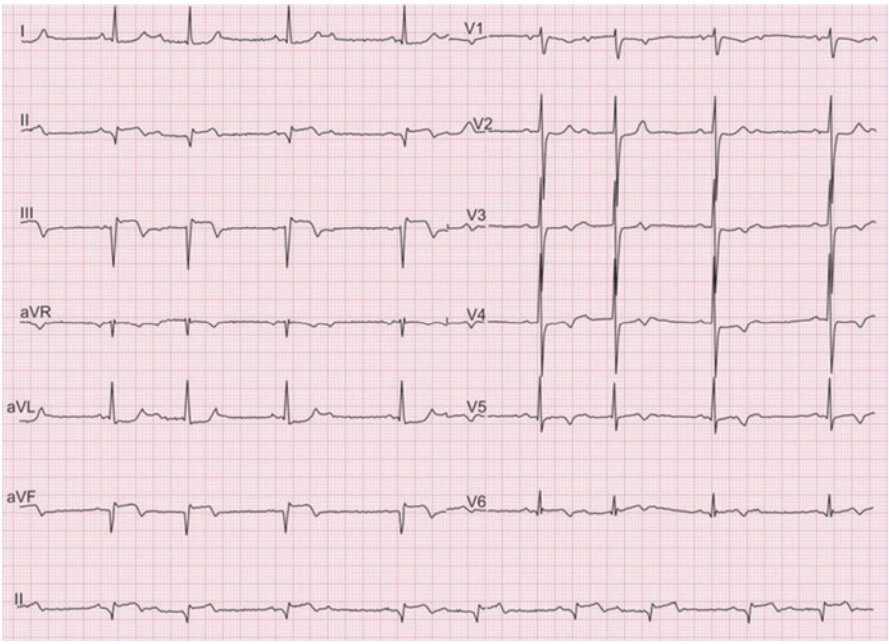
Forty-five years old man with history of dyslipidemia and heavy smoking has been referred to ER due to severe chest pain.



- ECG: sinus Rhythm.
- 115/min.
- St-Segment elevation in inferior leads (II > III and posterior leads).
- Prominent R wave in v1.
- ST depression and T wave inversion in V2-V4.
- ST-segment depression in V4R.
- Diagnosis: acute inferior posterior STEMI most probably due to LCX occlusion [1].

Case 19

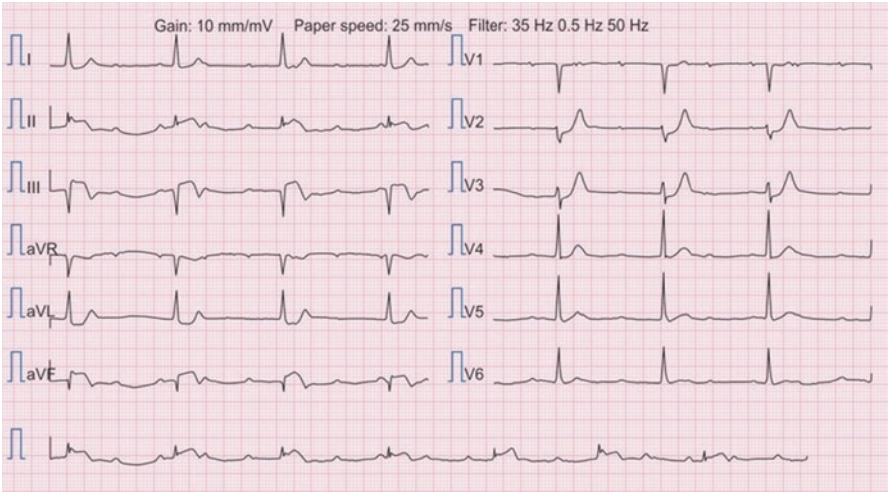
Forty years old man with typical chest pain and sweating since 1 day ago.



- ECG: sinus Rhythm.
- Q waves in inferior leads.
- ST. elevation in leads II, III, AVF.
- Progressive prolongation of PR interval.
- Diagnosis: type I second-degree AV block (Mobitz type I) due to inferior ST elevation myocardial infarction (STEMI) [5].

Case 20

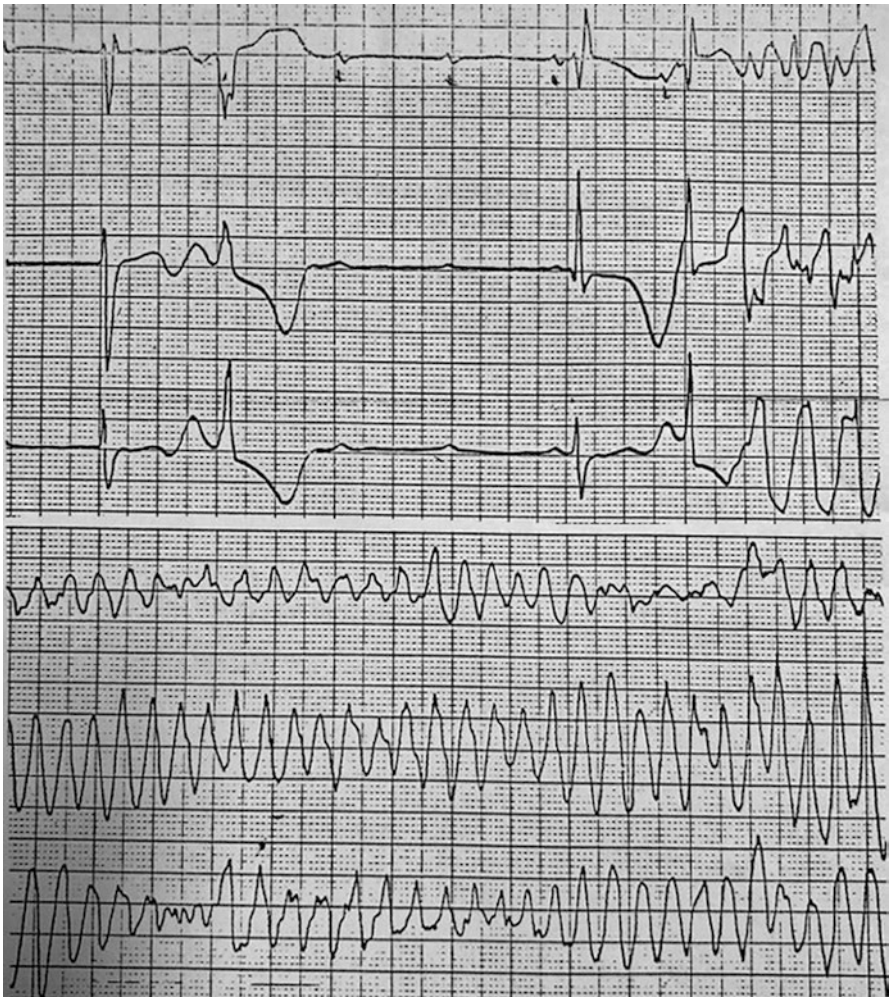
Fifty years old man with typical chest pain, nausea, vomiting, and vertigo.



- ECG: Atrial rate 100/min.
- Ventricular rate 40/min.
- AV dissociation (No relation between atrial and ventricular complexes).
- Q wave and ST elevation in inferior leads.
- Diagnosis: complete AV nodal block due to inferior ST elevation MI [5].

Case 21

Twenty years old unconscious man who has been admitted to the ER he had history of severe weight reduction in recent month. (lead v1).



- ECG: Sinus rhythm.
- High degree Av block. Occasional sinus capture beat and PVC.
- QRS rotation about the baseline.
- DX: Episode of torsade de pointe.
- Most probably due to prolonged QT secondary to weight reduction and may be hypokalemia [6].

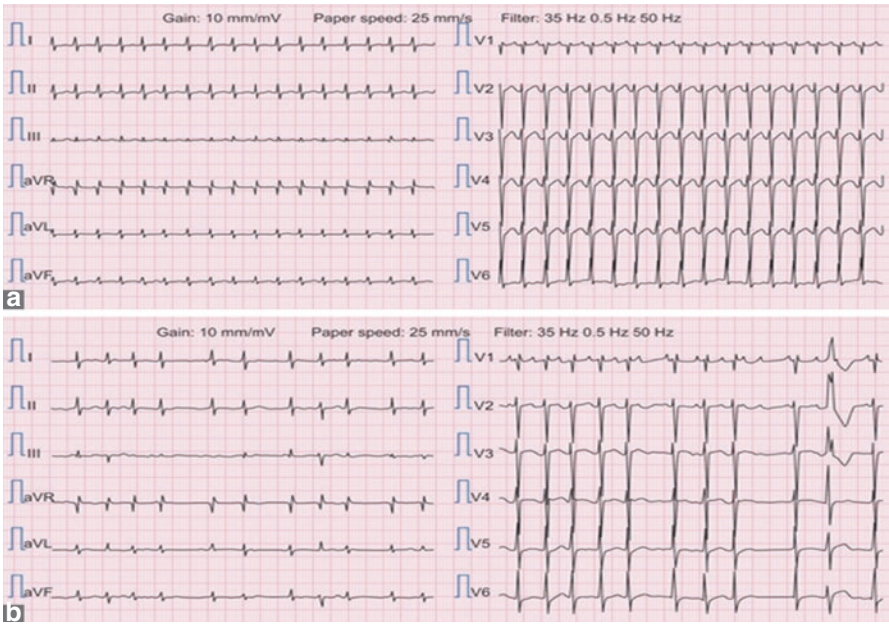
Case 22

Fifteen years old asymptomatic boy with incidental ECG finding.

- ECG: sinus rhythm.
- PR interval progressively lengthen (first and second p wave) before the dropped beat (third p wave).
- R-R interval shortening suggestive of second-degree type 1 Av block (Mobitz type I).

Case 23

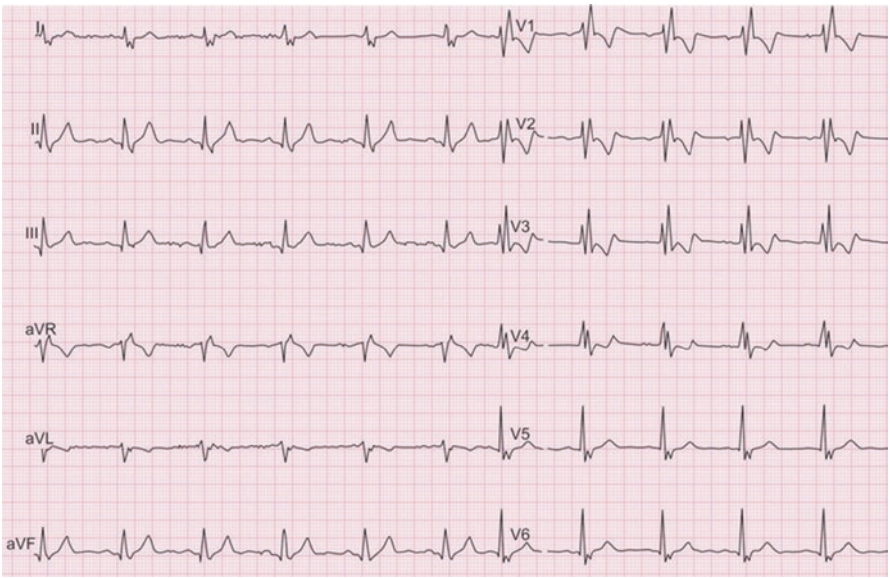
Twenty years old apparently healthy woman with history of frequent palpitation since last year.



- ECG A: narrow QRS tachycardia.
- HR: 160/min.
- Normal axis.
- 1:1 Av association.
- DX: Atrial tachycardia with one to one atrioventricular conduction.
- ECG B: after rate control.
- Irregular narrow QRS tachycardia.
- With varied Av conduction and Ashman phenomenon before the last beat.
- Note: Ashman phenomenon usually is seen in AF with rapid ventricular response. According to the electrophysiology role, the longer the cycle, the longer the refractory period and vice versa so after a long pause preceding a beat if there is a short cycle beat it shows RBBB pattern. This is because usually, the right bundle has a longer refractory period than the left bundle branch [3].

Case 24

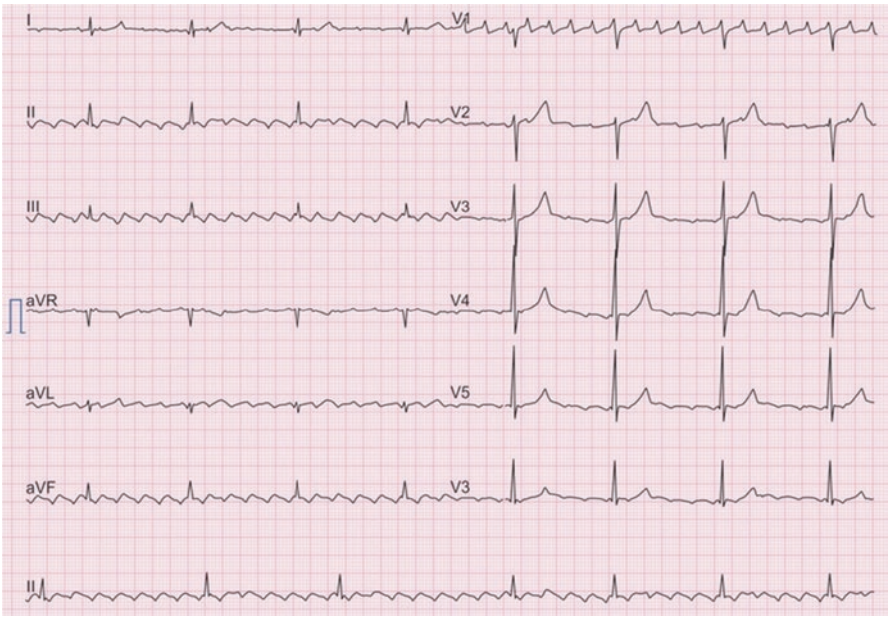
Twenty years old man with dyspnea on exertion (Fc, II), fixed splitted second heart sound and II/VI ejection systolic murmur in left sternal border.



- ECG: NSR 100/min.
- Normal axis.
- Terminal r delay in D1.
- rSr' pattern in lead v1.
- s wave in lead I>/40 ms wide, and late intrinsicoid (prolonged time to peak r' wave in v1 is indicative of RBBB in v1).
- Diagnosis: Right bundle branch block most probably due to atrial septal defect secundum [1].

Case 25

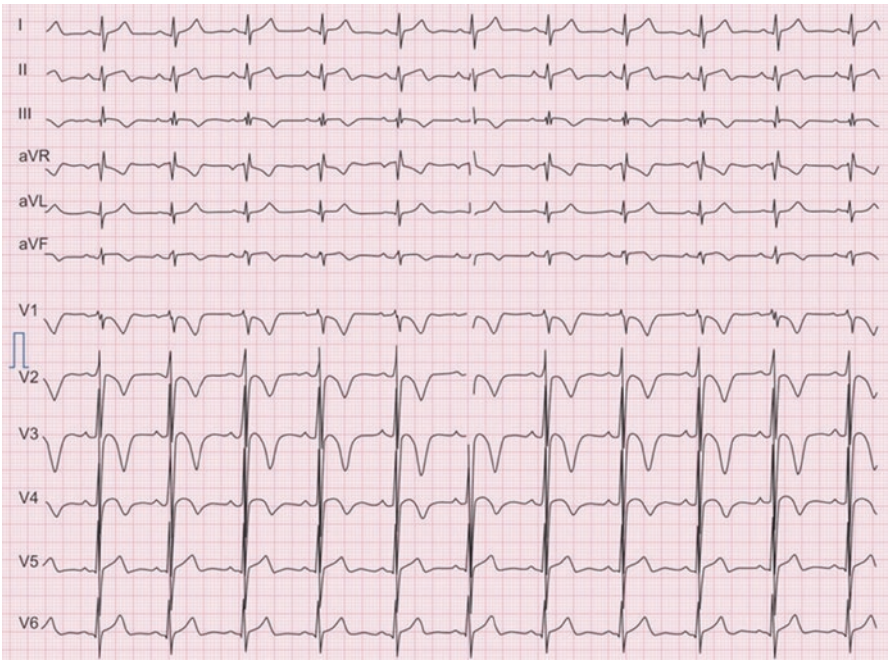
Thirty-five years old lady with history of rheumatic fever and severe mitral stenosis since many years ago.



- ECG.
- HR: 55 min.
- Normal axin.
- Negative flutter wave in inferior lead and upright in v1.
- Counter clockwise atrial flutter with varied AV conduction.
- Dx: atrial flutter with slow ventricular response [4].

Case 26

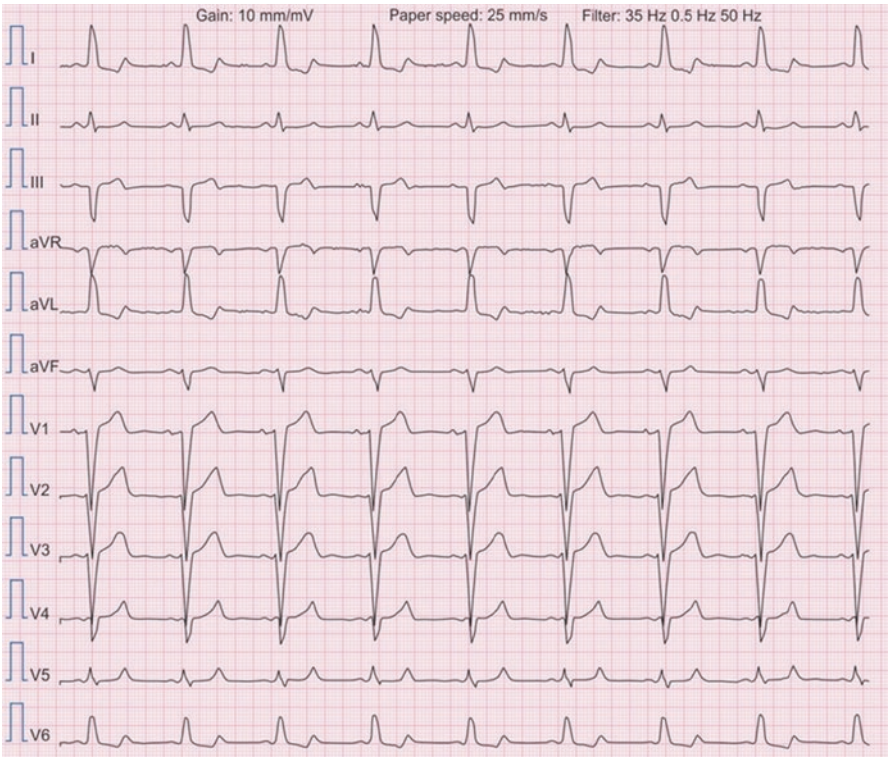
Thirty years old pregnant woman who has been admitted due to severe dyspnea since one night before.



- ECG: NSR, 70/min.
- S1 Q3 T3 pattern, RAD.
- T wave inversion in v1-v4 suggesting RV overload, incomplete RBBB.
- Dx: ECG pattern compatible with submissive pulmonary embolism considering patient history [7].

Case 27

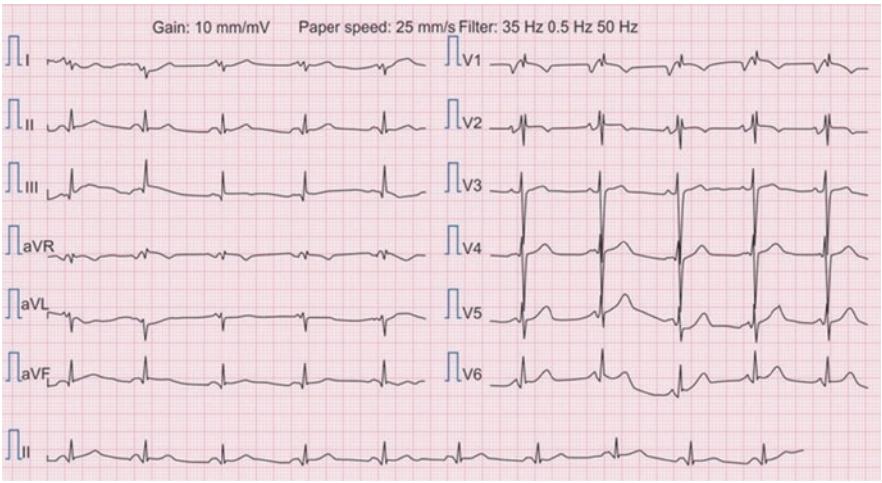
Forty years old asymptomatic man with history of longstanding hypertension.



- ECG.
- NSR, 75/min.
- LAD.
- Broad R wave in leads I, AVL, V5, and V6.
- Absent initial r wave in v1.
- Absent septal q wave in lead I, V5, and V6.
- Dx: complete left bundle branch block (LBBB) [3].

Case 28

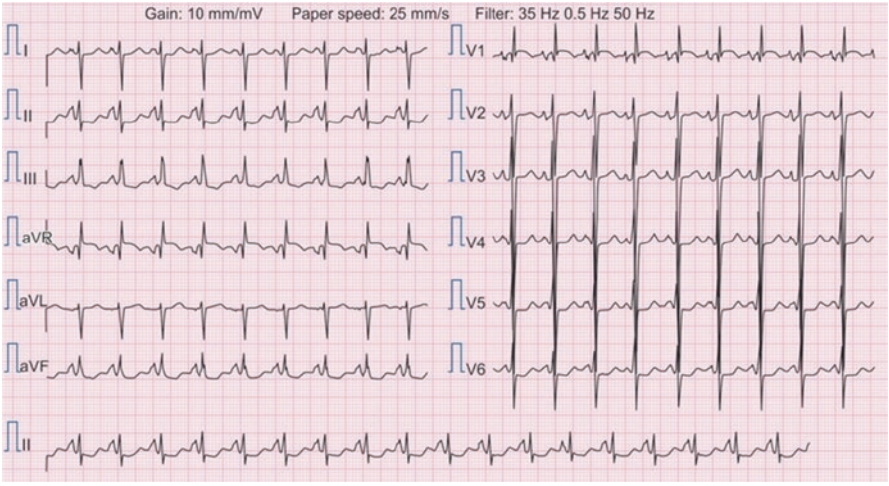
Thirty years old woman with history of Rheumatic fever (RF (who has been referred due to DOE (FC II) and palpitation since 1-year ago.



- ECG: NSR, 80/min.
- Prolonged P wave duration in lead II.
- Increased duration and depth of terminal negative portion of P wave in lead V1.
- LAA, RAD, incomplete RBBB.
- DX: NSR, LAA, RVH, RBBB most probably due to mitral stenosis [1].

Case 29

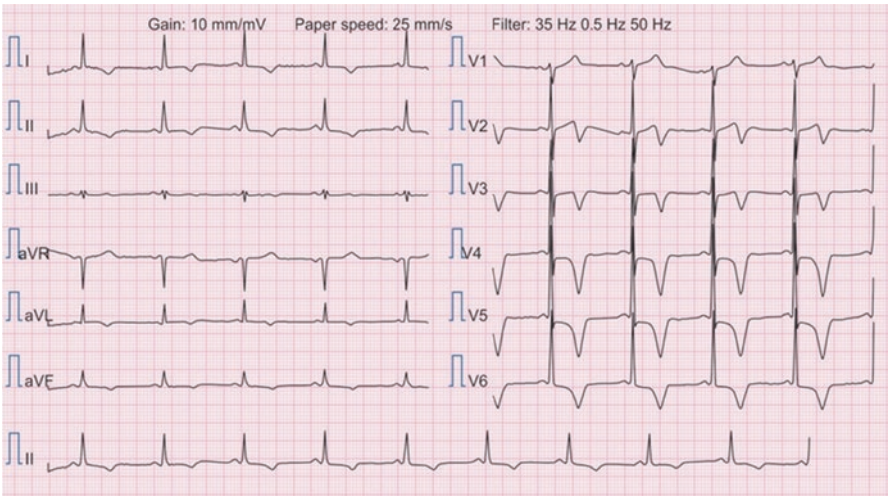
Twenty-five years old woman with history of RF in childhood. Physical exam showed diastolic rumble accentuated first heart sound (S1) and systolic murmur with inspiratory accentuation in the left sternal border.



- ECG: Sinus Rhythm.
- HR, 140/min.
- RAD, tall P in lead II.
- Abnormal large terminal negative component of the P wave in V1 peaked P in II.
- DX: BAA, RAD, RVH probably due to mitral stenosis and tricuspid regurgitation [2].

Case 30

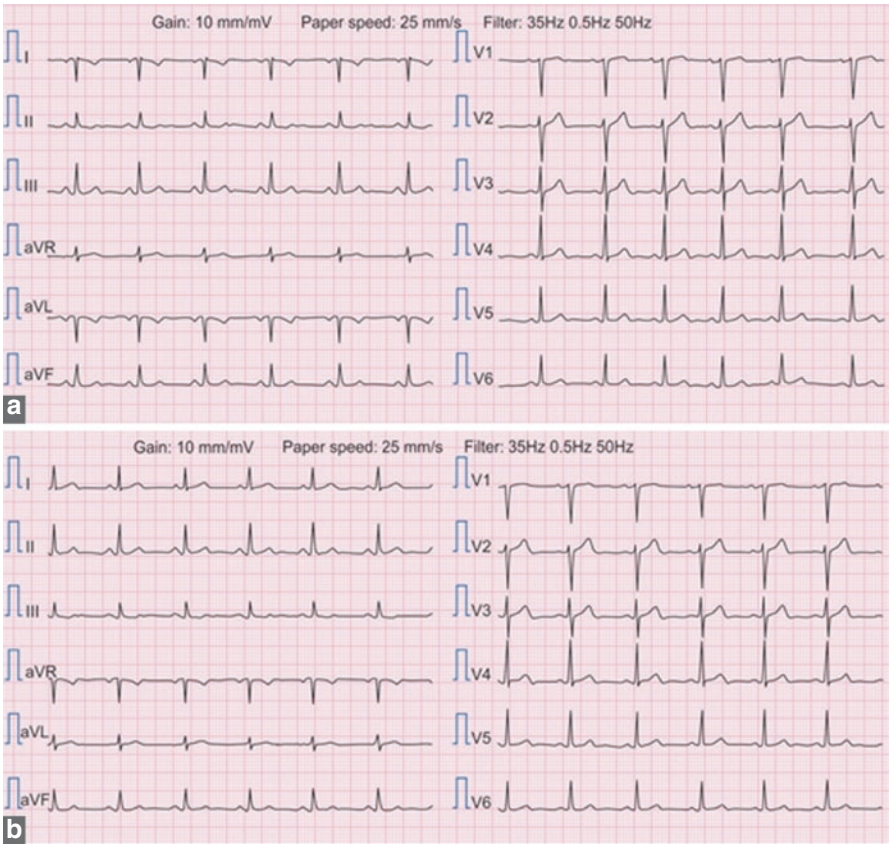
Thirty-five years old man with atypical chest pain with a diagnosis of extensive Ischemia and probable old myocardial infraction.



- ECG: NSR.
- Normal axis.
- HR: 90/min.
- Prominent downward ST-segment depression. Deep asymmetrical T wave inversion in precordial leads.
- DX: LVH most probably due to apical hypertrophic cardiomyopathy (HCM) (Yamaguchi Syndrome).
- Note: The echocardiogram confirmed the diagnosis and angiography showed normal coronary arteries [5].

Case 31

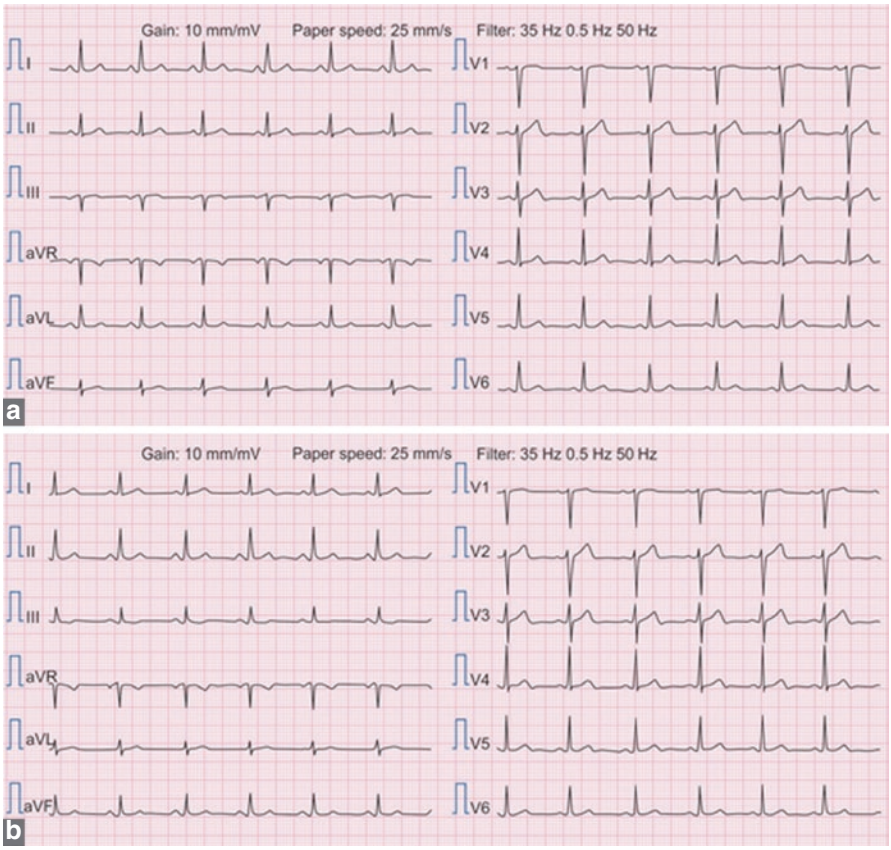
Twenty-five years old man with atypical chest pain.



- ECG: Incorrect placement of limb leads (right and left arm reversal) in Figure A and the correct of the leads in a healthy individual in Figure B. Note to inversion in lead I, marked right axis deviation, reversal of leads II and III, reversal of leads aVR and aVL, and unchanged leads aVF and pericardial (A) as compared to normal ECG (B) [8].

Case 32

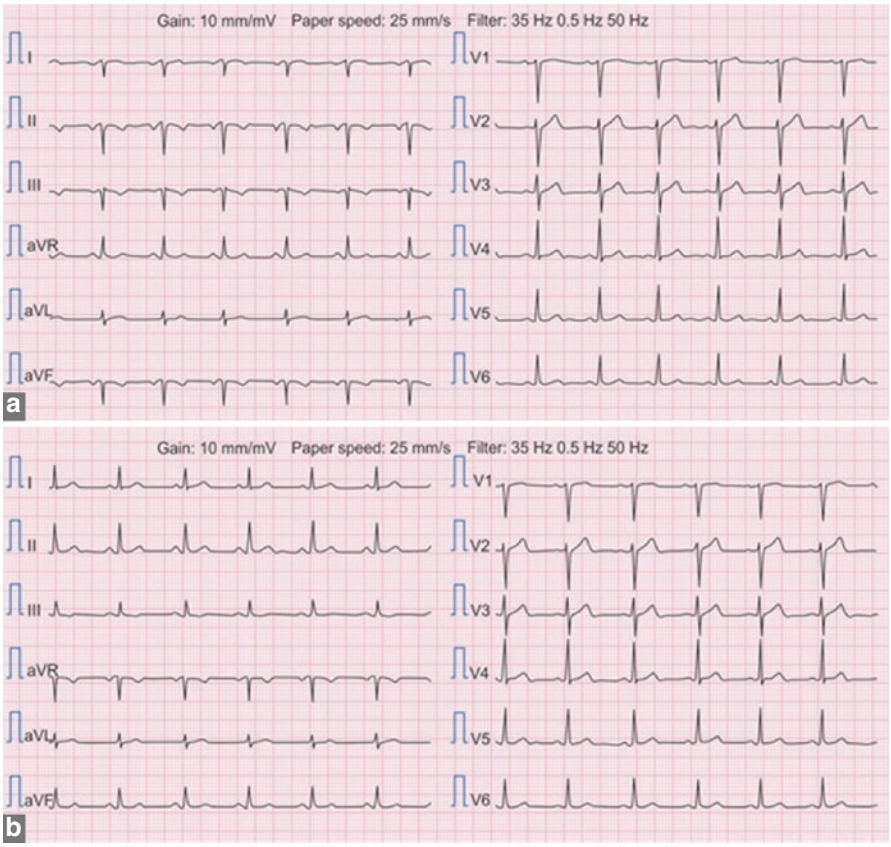
Forty years old obese woman who has been referred for a routine checkup.



- ECG: Incorrect placement of limb leads (left arm and left leg reversal) in Figure A and the correct of the leads in a healthy individual in Figure B. Note to reversal of leads I and II, reversal of leads aVL and aVF, inversion of lead III, and unchanged leads aVR and pericordial (A) compared to normal ECG (B) [9]

Case 33

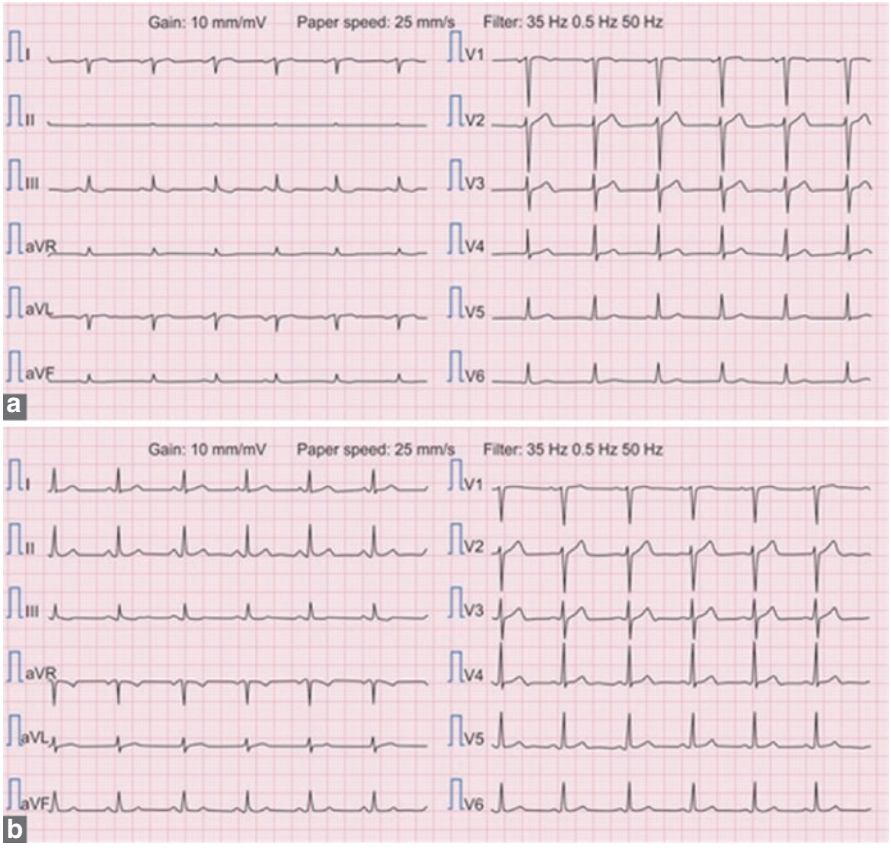
Eighteen years asymptomatic old boy who has been referred for evaluation of cardiovascular system due to ECG misdiagnosis.



- ECG: Incorrect placement of limb leads (right arm and left leg reversal) in Figure A and the correct of the leads in a healthy individual in Figure B. Note to inversion of leads I, II, and III, reversal of leads I and III, reversal of leads aVR and aVF, and unchanged leads aVL and pericordial (A) compared to normal ECG (B) [8].

Case 34

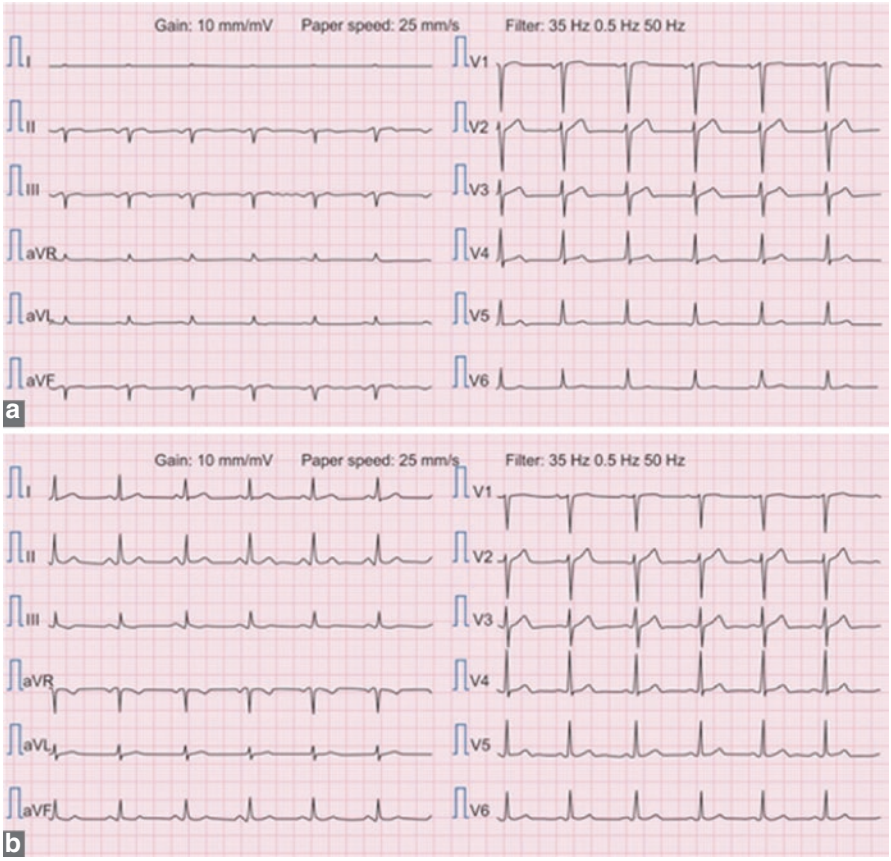
Thirty-five years old man with atypical chest pain who has been diagnosis old lateral wall myocardial infarction by general practitioner.



- ECG: Incorrect placement of limb leads (right arm and right leg reversal) in Figure A and the correct of the leads in a healthy individual in Figure B. Note to diminished signal (zero potential) in lead II, lead I that inverted lead III, leads aVR and aVF identical, lead aVL that approximates an inverted lead III, and unchanged precordial.
- leads (A) compared to normal ECG (B) [9].

Case 35

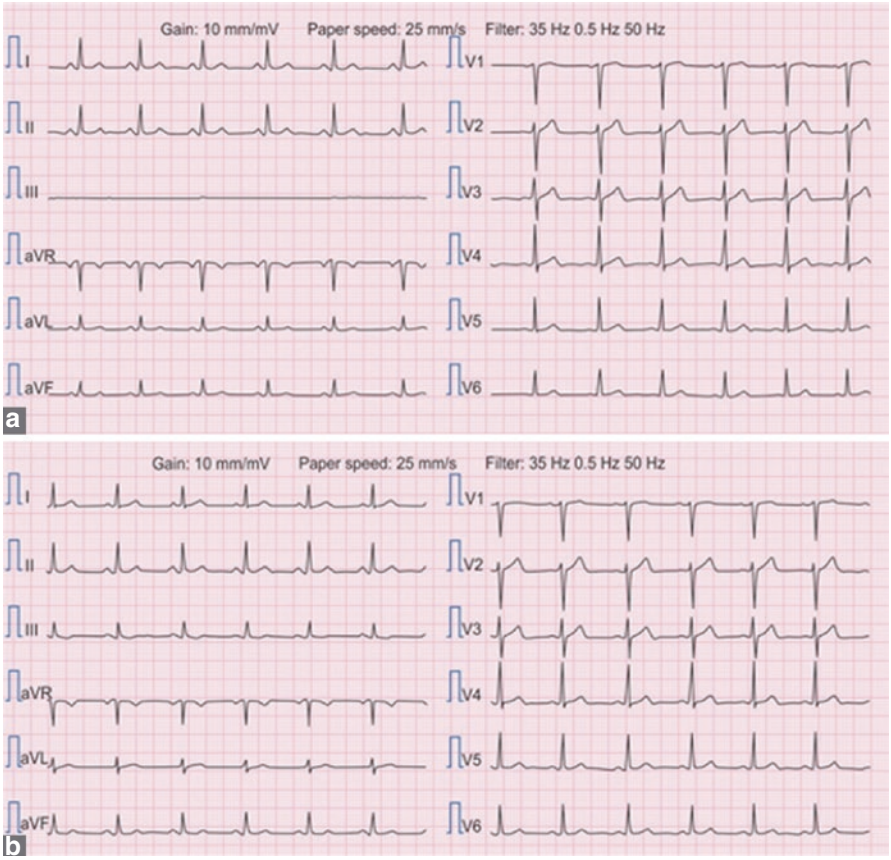
Thirty years old man with chest pain and misdiagnosis of inferior wall myocardial infarction by an intern in general hospital.



- ECG: Incorrect placement of limb leads (bilateral arm-leg reversal) in Figure A and the correct of the leads in a healthy individual in Figure B. Note to diminished signal (zero potential) in lead I, inversion of leads III, leads aVR and aVL that become identical, lead II and aVF that becomes approximately an inverted lead III, and unchanged precordial leads (A) compared to normal ECG (B) [9].

Case 36

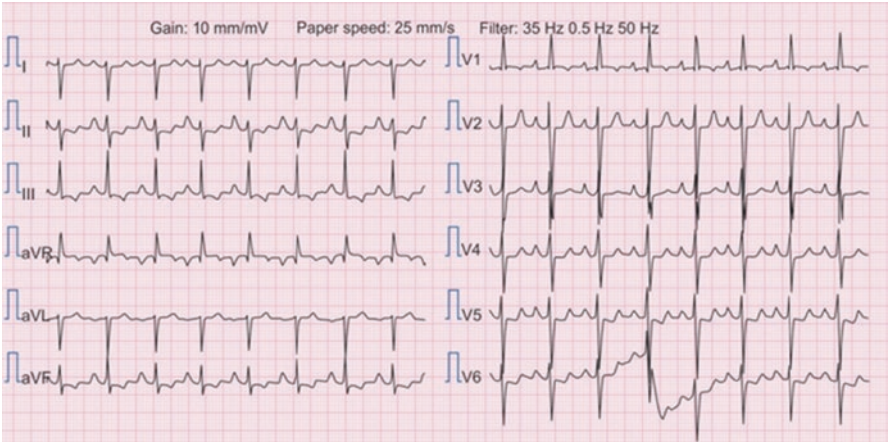
Twenty years asymptomatic old boy with incidental finding in ECG.



- ECG: Incorrect placement of limb leads (left arm and right leg reversal) in Figure A and the correct of the leads in a healthy individual in Figure B. Note to lead I that becomes identical to lead II, diminished signal (zero potential) in lead III, lead aVR that approximates to an inverted lead II, leads aVL and aVF that become identical, unchanged leads II and pericordial (A) compared to normal ECG (B) [8].

Case 37

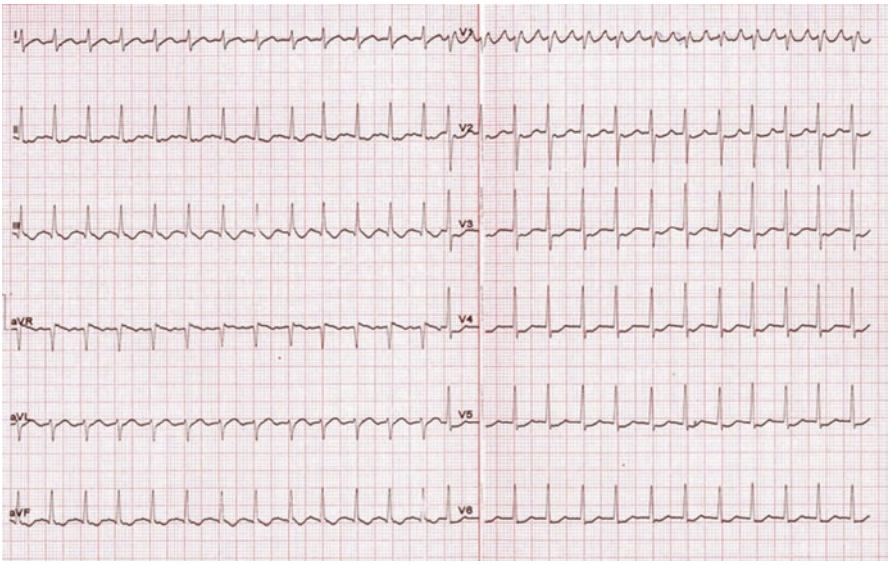
Forty-five years old man with history of heavy smoking since 20 year ago. He has been referred due to Doe (Fc, II) with cough and sputum since 6 month ago.



- ECG: NSR
- HR: 130/min
- Axis: RAD, large P wave in lead II and prominent initial positivity in V1 (p pulmonale) suggestive right atrial abnormality.
- Dominate R wave in V1 (7 mm tall and R/S in V1>1), dominant S more than r in V6. Reversal of normal R wore progression in precordial leads.
- Dx: RAA, RVH most probably due to cor pulmontal [10].

Case 38

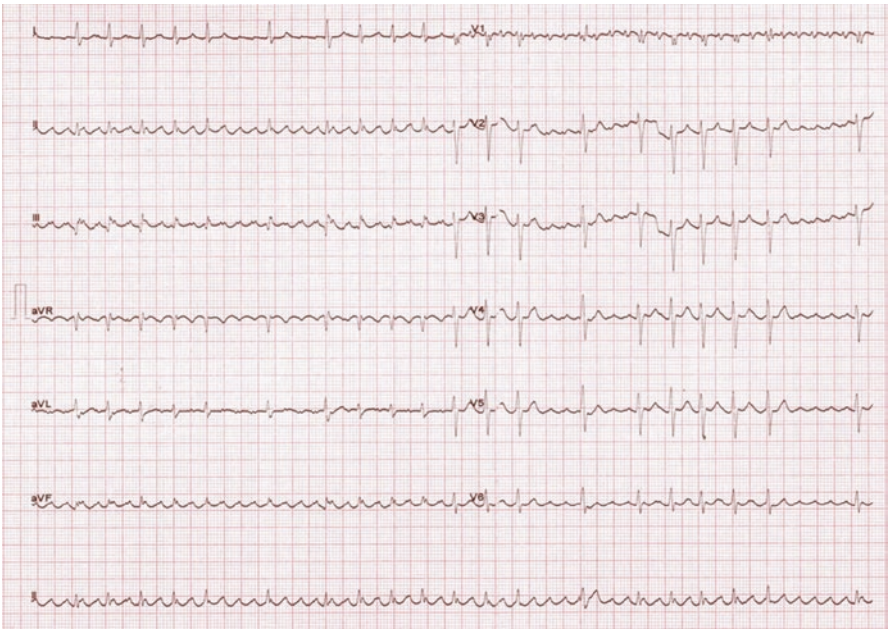
Thirty-year-old woman with history of mitral stenosis and palpitation.



A counterclockwise atrial flutter. Note that the flutter waves are negative in inferior leads and upright in V1. The atrial rate is 300 beats/min and the ventricular rate is 150 beats/min (two-to-one AV conduction).

Case 39

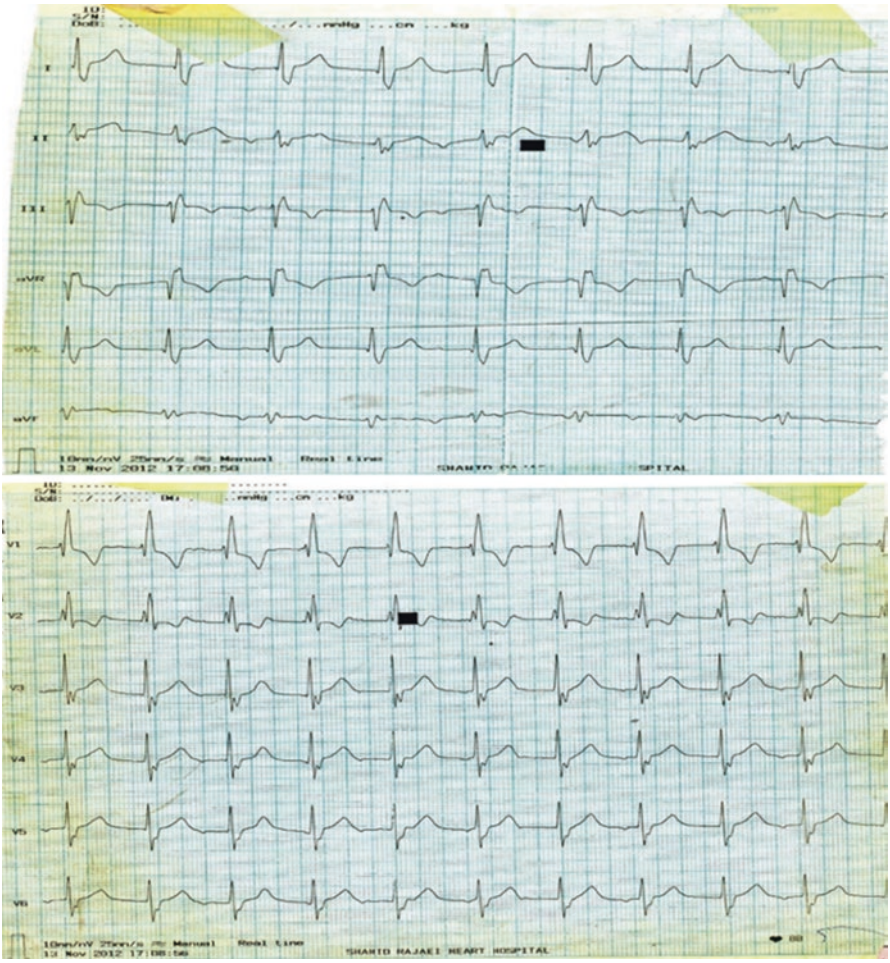
Thirty-five years old man with history of rheumatic heart disease and frequent palpitation since a few months ago.



A clockwise atrial flutter with varied AV conduction. Note that the flutter waves are positive in inferior leads and negative in V1 [1].

Case 40

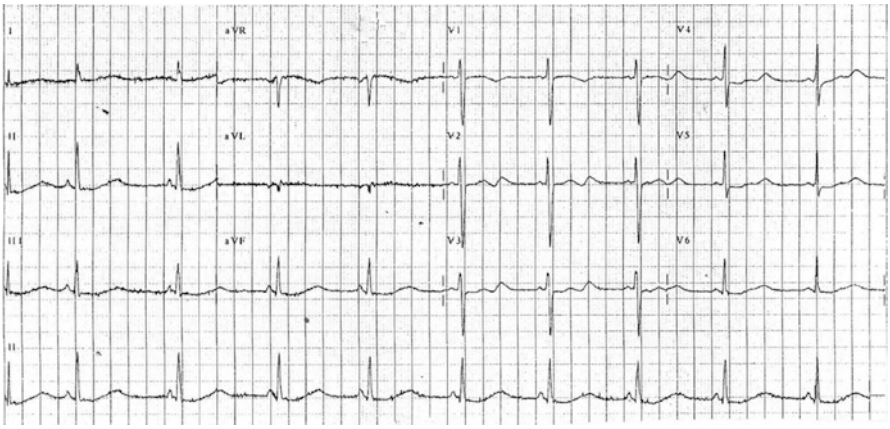
Forty years old lady with history of DOE (Fc: IIII) Since many years ago. She had recently atrioventricular septal defeat repair.



- ECG: wide QRS (RBBB pattern) with 85 bpm.
- Visible inverted P wave in leads II and III.
- Left axis deviation.
- Terminal S in DI rsr' in V1.
- Diagnosis: RBBB, LAHB, non-paroxysmal junctional tachycardia.
- Note: RBBB plus LAD in most often seen in endocardial cushion defect. NPJT in common after mitral valve repair or replacement, myocarditis, inferior MI.

Case 41

Eighteen years old girl with history of anorexia and vomiting.



- ECG: Sinus bradycardia.
- 55 bpm.
- Normal axis.
- Small or T wave.
- Long QT.
- Note: Bulimia, vomiting, and hypokalemia in a young girl can cause Long QT interval and probably torsade de pointes [6].

Case 42

Fifty years old man with history of palpitation and DOE (Fc, II) Since 1 year ago. Echocardiogram in compatible with dilated cardiomyopathy.

- ECG: AF with rapid ventricular response.
- Absence of Q wave in I, AVL, V4-v6.
- LBBB pattern.
- Occasional PVC.
- Note: Although there is long cycle, short cycle in V1 and wide QRS with RBBB pattern but in fact it is PVC because of already LBBB and wide QRS with compensatory pause. it is not Ashman phenomenon.

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