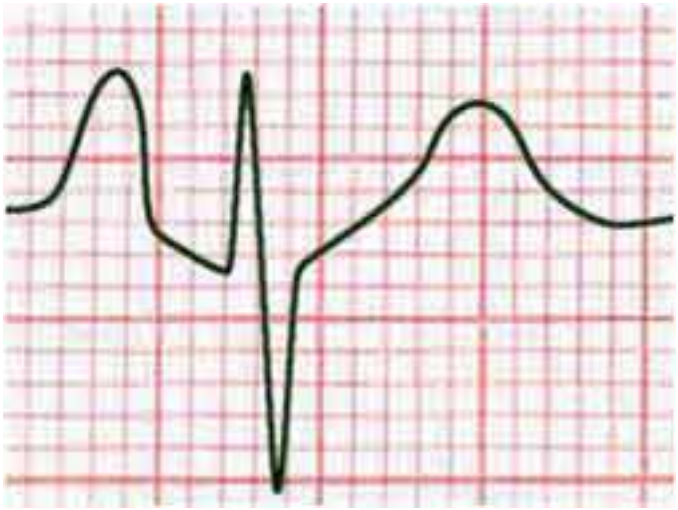
Other Assorted ECG Findings

Chamber Enlargement

- Dilatation = Distention of an individual heart chamber
- Hypertrophy = Chronic condition of the heart
- Each of these affect ECG differently
  - Dilatation results in prolongation of P wave duration
  - Hypertrophy results in QRS of larger amplitude

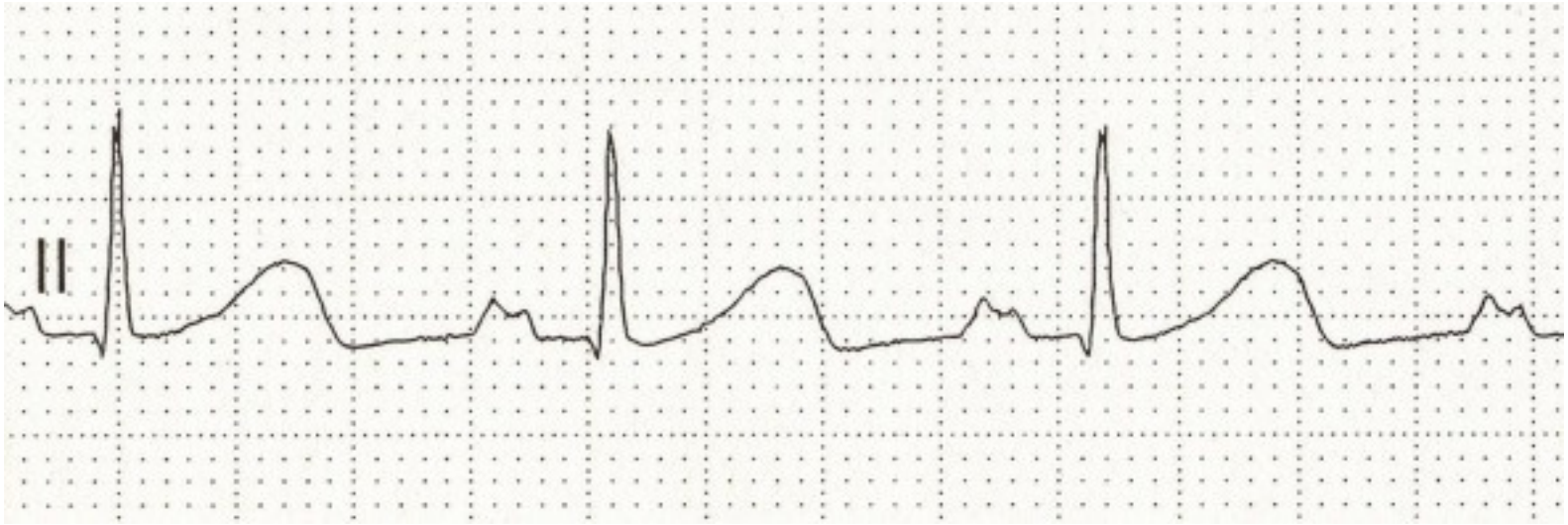
Right Atrial Enlargement

- Right atrial overload
- Results in tall, symmetrically peaked P wave – P pulmonale



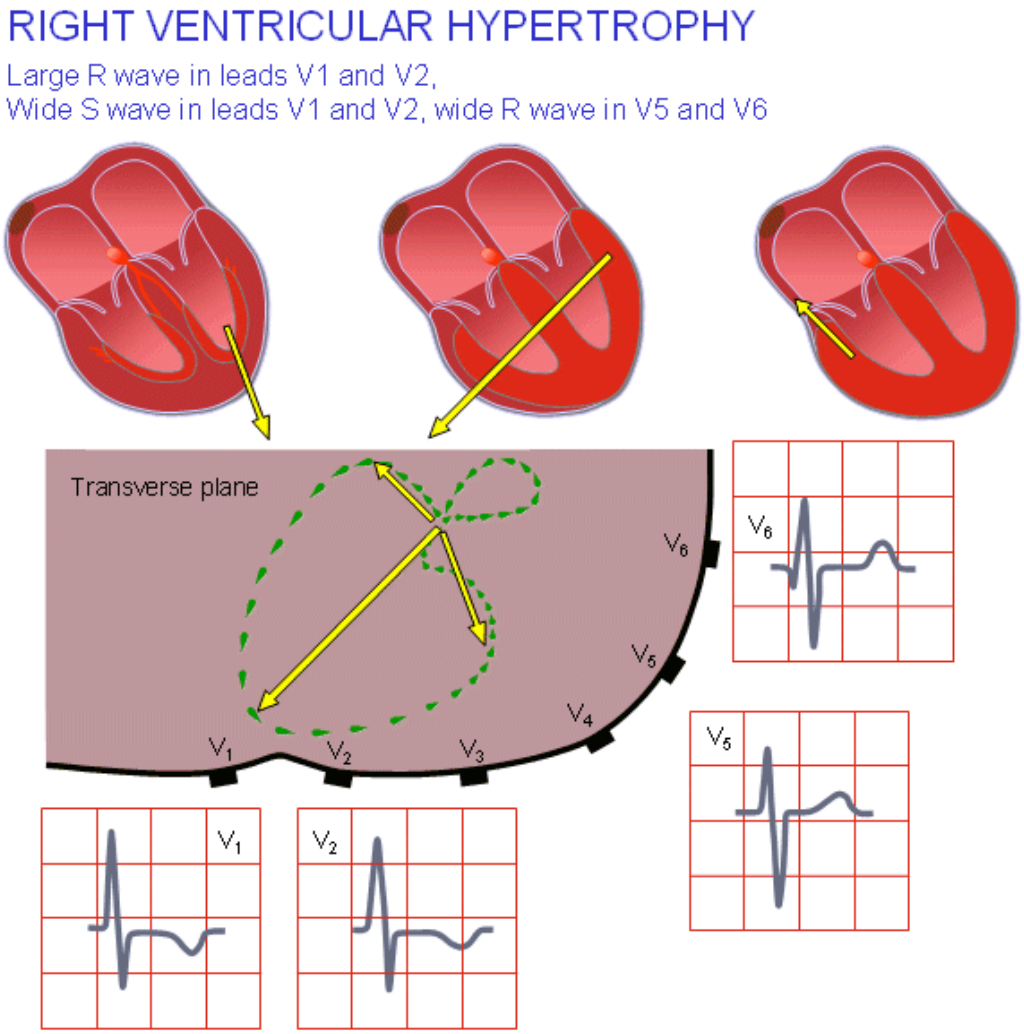
Left Atrial Enlargement

- Left atrial overload
- Results in wide notched P wave – P mitrale



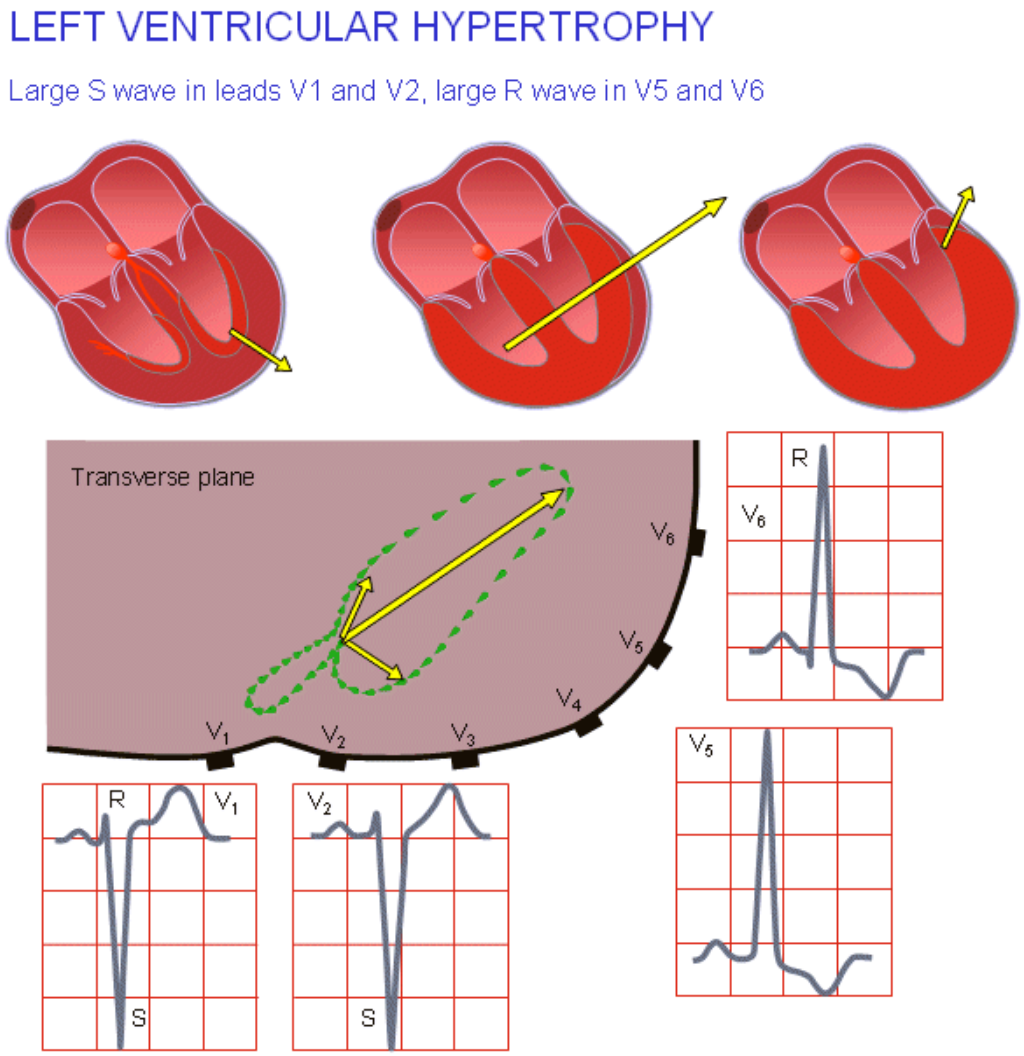
Right Ventricular Hypertrophy

- Right ventricular overload
- Produces abnormally large rightward electrical forces that travel toward lead V_1 and away from left precordial leads V_5-V_6



Left Ventricular Hypertrophy

- Left ventricular overload
- Produces abnormally large leftward electrical forces that travel toward the left precordial leads V_5-V_6 and away from lead V_1



Pericarditis

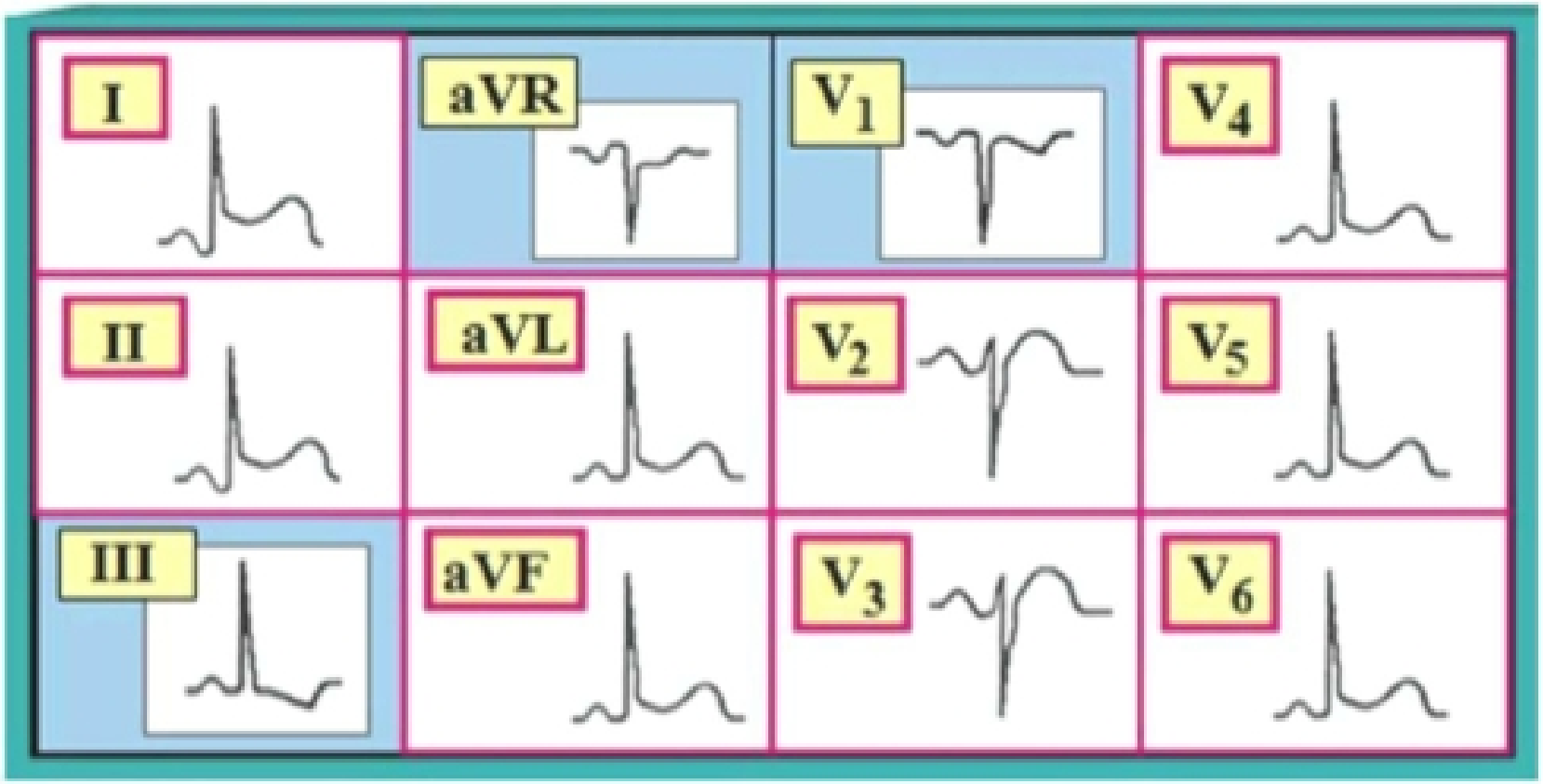
- Inflammatory disease of pericardium

- Chest pain is sharp and severe
  - Made worse by laying flat
  - Relieved by sitting up or leaning forward
  - Often made worse by breathing
  - May last for hours or days

Pericarditis

- ECG findings
  - Elevated PR segment in lead aVR
  - Depressed PR segment in other limb leads and left chest leads
  - QRS are low voltage
  - ST-segment elevation is main ECG abnormality
  - Inverted T waves in leads with ST-segment elevation

Pericarditis



Hyperkalemia

- Excess of serum potassium
- Most common causes:
  - Kidney failure
  - Certain diuretics
- ECG characteristics:
  - P waves begin to flatten out and become wider
  - PR intervals may be normal or prolonged
  - QRS complexes begin to widen
  - ST segments disappear
  - T waves become narrow, tall, and peaked

Hyperkalemia

Serum potassium	Typical ECG appearance	Possible ECG abnormalities
Mild (5.5-6.5 mEq/L)		Peaked T waves Prolonged PR segment
Moderate (6.5-8.0 mEq/L)		Loss of P wave Prolonged QRS complex ST-segment elevation Ectopic beats and escape rhythms
Severe (>8.0 mEq/L)		Progressive widening of QRS complex Sine wave Ventricular fibrillation Asystole Axis deviations Bundle branch blocks Fascicular blocks

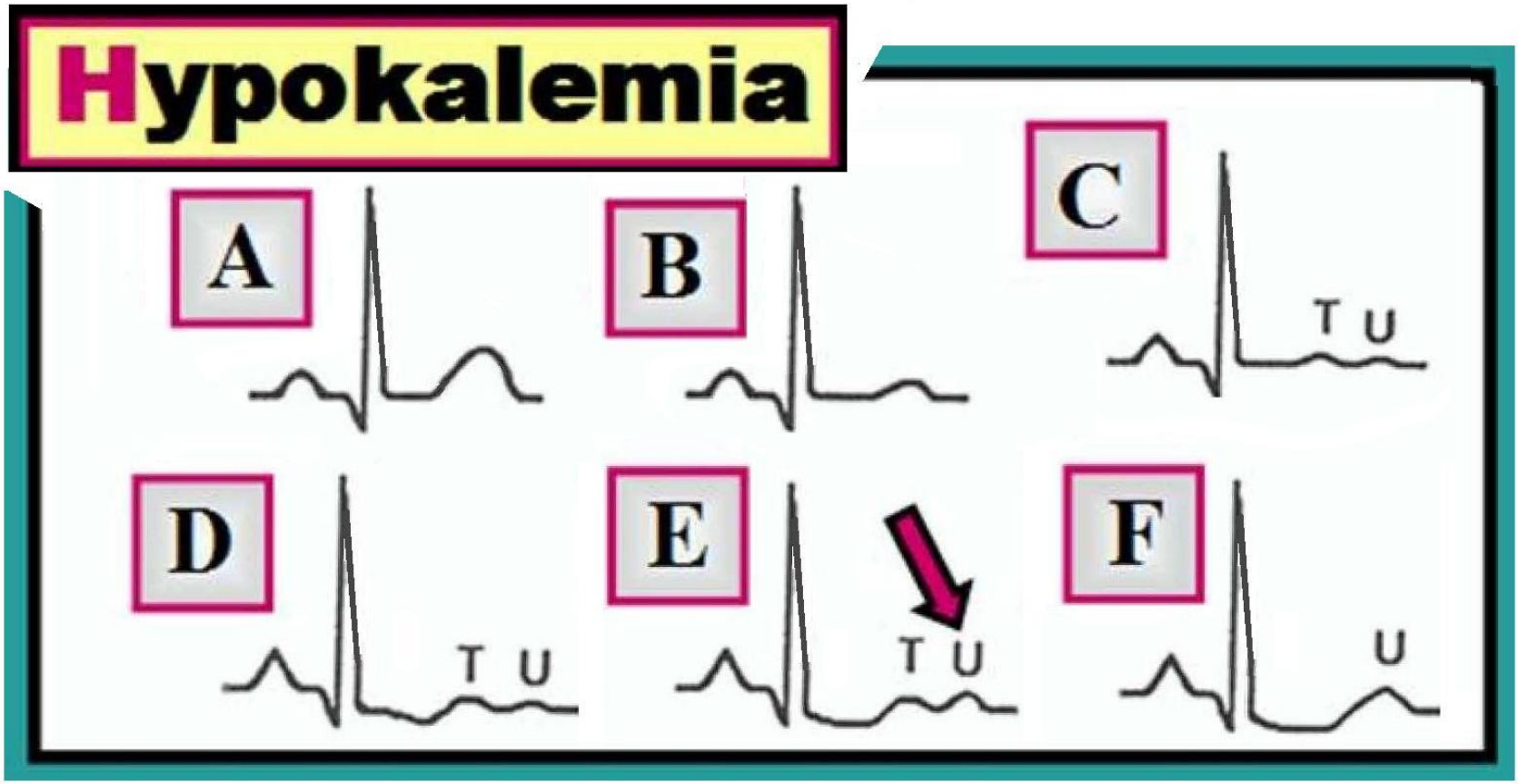
Hypokalemia

- Deficiency of serum potassium below normal
- Most common cause is loss of potassium in body fluids through:
  - Vomiting
  - Gastric suction
  - Excessive use of diuretics
- May also result from low serum magnesium levels
- Symptoms:
  - Polyuria (large passage of urine)
  - Muscle weakness

Hypokalemia

- ECG characteristics:
  - P waves become typically tall and symmetrically peaked
    - Resemble P pulmonale
      - Called “pseudo P pulmonale”
  - QRS begins to widen
  - ST segments may become depressed by 1 mm or more
  - T waves begin to flatten
  - U waves begin to increase in size, becoming as tall as T waves
  - QT intervals may appear to be prolonged when U waves become prominent and fuse with T waves

Hypokalemia

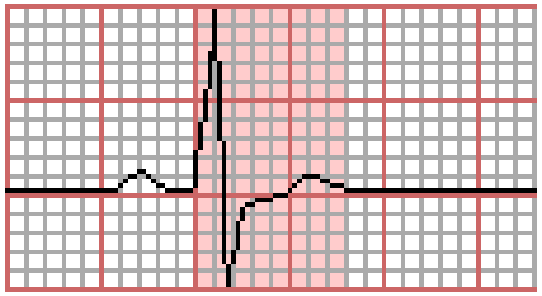


Hypercalcemia

- Excess of serum calcium above normal
- Severe hypercalcemia is life threatening
- Digitalis in presence of hypercalcemia may cause serious dysrhythmias
- ECG characteristics:
  - QT intervals are shorter than normal for HR

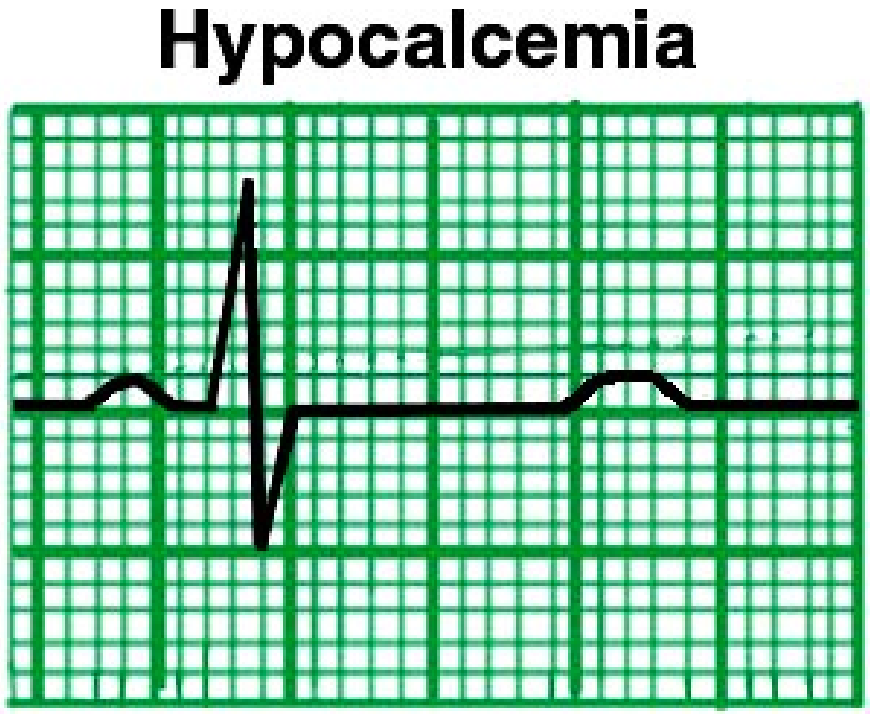
Hypercalcemia

- Short QT because of short ST segment



Hypocalcemia

- Shortage of serum calcium below normal
- ECG characteristics :
  - ST segments are prolonged
  - QT segments are prolonged beyond normal limits for HR



Digitalis

- When administered in therapeutic range, produces characteristic changes in ECG
- Excitatory effects:
  - PACs
  - Atrial tachycardia with or without block
  - PVCs
  - V Tach
  - V Fib
- Inhibitory effects:
  - Sinus bradycardia
  - SA exit block
  - AV block

Digitalis

- ECG characteristics:
  - Prolonged PR intervals
  - Depressed ST segments 1 mm or more – scooped out appearance
  - Flattened, inverted, or biphasic T waves
  - QT intervals shorter than normal for HR

Procainamide

- Exhibitory effects:
  - PVCs
  - V tach in the form of torsades de pointes
  - V fib
- Inhibitory effects:
  - Depression of myocardial contractility, which may cause hypotension and CHF
  - AV block
  - Asystole

Procainamide

- ECG characteristics:
  - Increased duration of QRS
    - Widening of QRS = sign of toxicity
  - R waves decreased in amplitude
  - T waves decreased in amplitude
    - Occasionally may be widened and notched because of appearance of U wave
  - Prolonged PR intervals
  - ST segments depressed by 1 mm or more
  - QT intervals may be prolonged beyond normal limits for HR = sign of toxicity

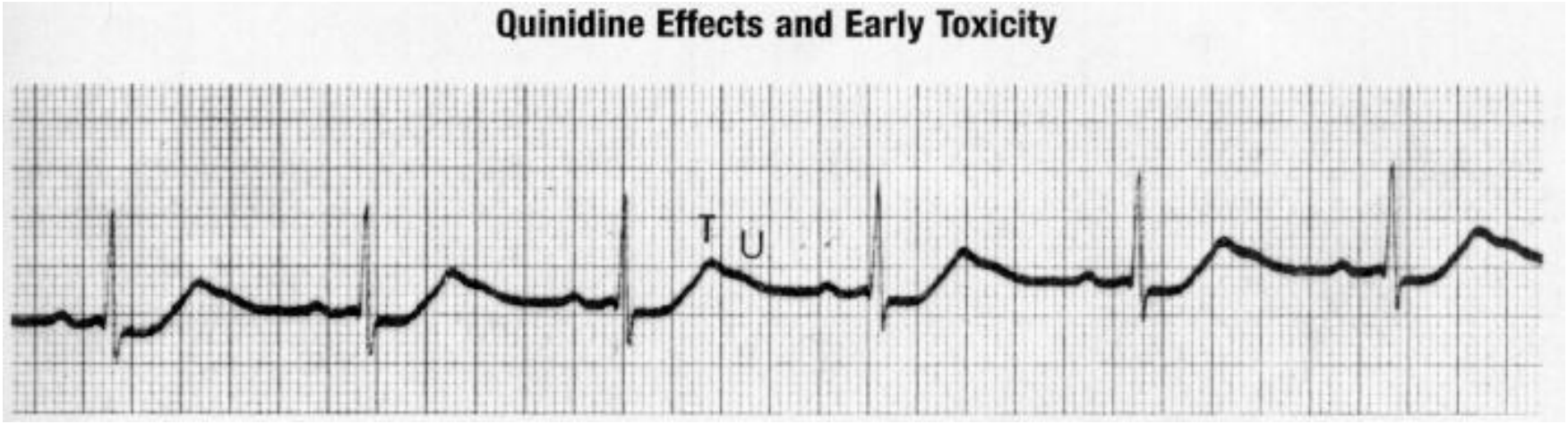
Quinidine

- Excitatory effects:
  - PVCs
  - V tach in the form of torsades de pointes
  - V fib
- Inhibitory effects:
  - Depression of myocardial contractility, which may cause hypotension and CHF
  - SA exit block
  - AV block
  - Asystole

Quinidine

- ECG characteristics:
  - P waves may be wide, often notched
  - Duration of QRS may be increased
    - Wide QRS = sign of toxicity
  - T waves may be decreased in amplitude, wide and notched or may be inverted
  - PR intervals prolonged
  - ST segments may be depressed 1 mm or more
  - QT intervals may be prolonged
    - Sign of toxicity

Quinidine



Acute Pulmonary Embolism

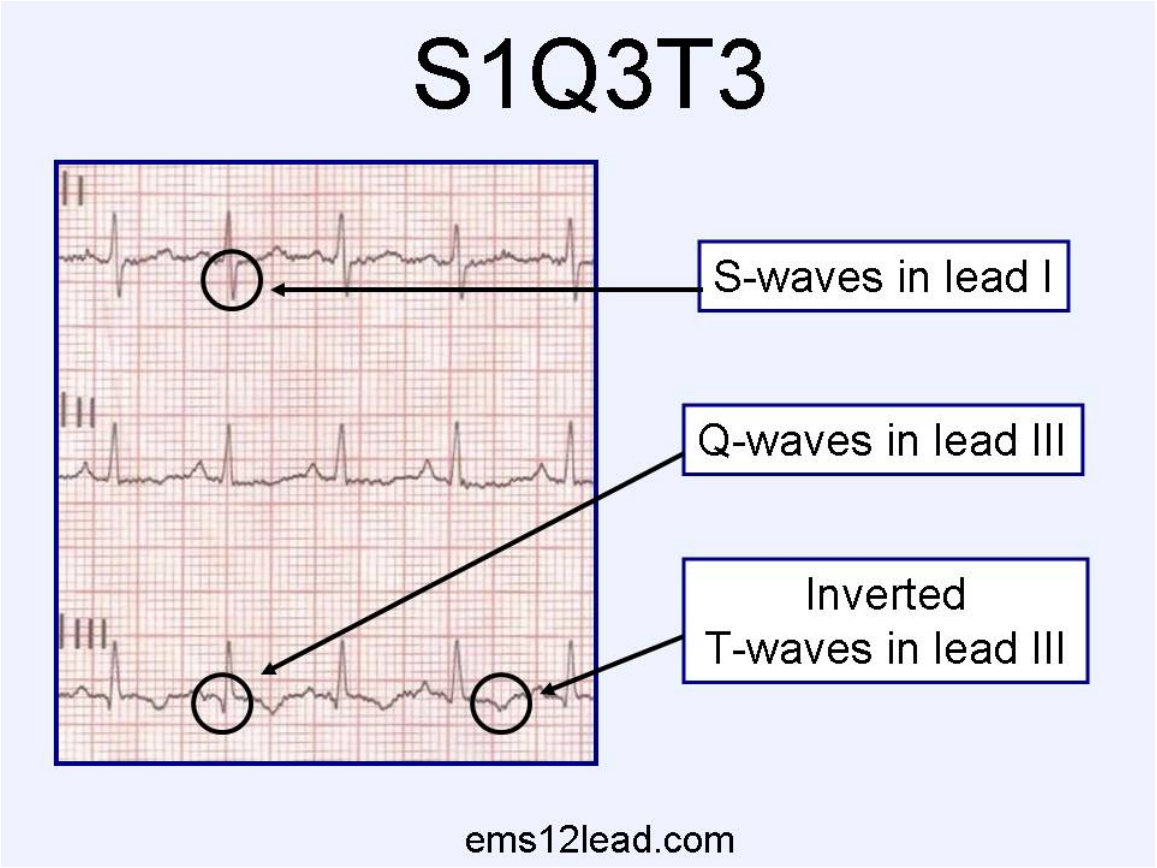
- Symptoms:
  - Sudden severe dyspnea
  - Anxiety, restlessness, and apprehension
  - Chilliness, dizziness, and mental confusion
  - Nausea, vomiting, and abdominal pain
  - Precordial or substernal chest pain like that of acute MI

Acute Pulmonary Embolism

- Signs:
  - Sinus tachycardia
  - Tachypnea, cough, and wheezing
  - Cyanosis
  - Distended neck veins
  - Forceful pulsation in the second left intercostal space with a systolic pulmonic murmur
  - Hypotension, shock, and rarely cardiac arrest

Acute Pulmonary Embolism

- ECG characteristics:
  - Tall, symmetrically peaked P waves in leads II, III, and aVF
  - Sharply peaked biphasic P waves in leads V_1 and V_2
  - Right bundle block may occur
  - Right ventricular "strain" pattern may be present



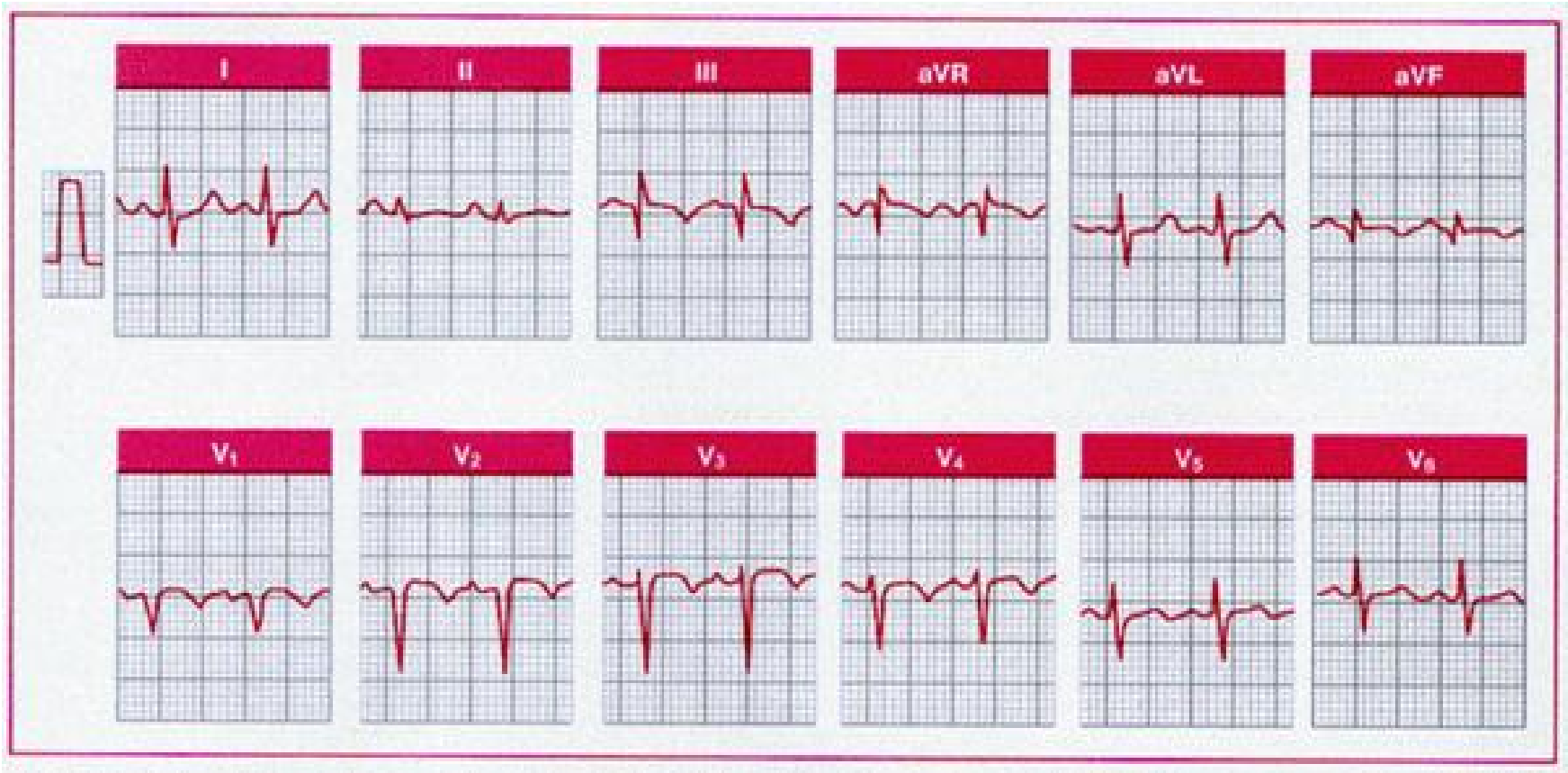
Chronic Cor Pulmonale

- Enlargement of RV commonly accompanied by right heart failure
  - End stage result of prolonged pulmonary hypertension
- Associated with:
  - PACs
  - Wandering atrial pacemaker
  - Multifocal atrial tachycardia
  - Atrial flutter
  - Atrial fibrillation

Chronic Cor Pulmonale

- ECG characteristics:
  - Changes indicative of right atrial enlargement in P waves
  - Changes indicative of right ventricular hypertrophy in QRS
  - QRS axis greater than 90 degrees
  - Right ventricular “strain” pattern present (inverted T waves in leads V_1-V_3)

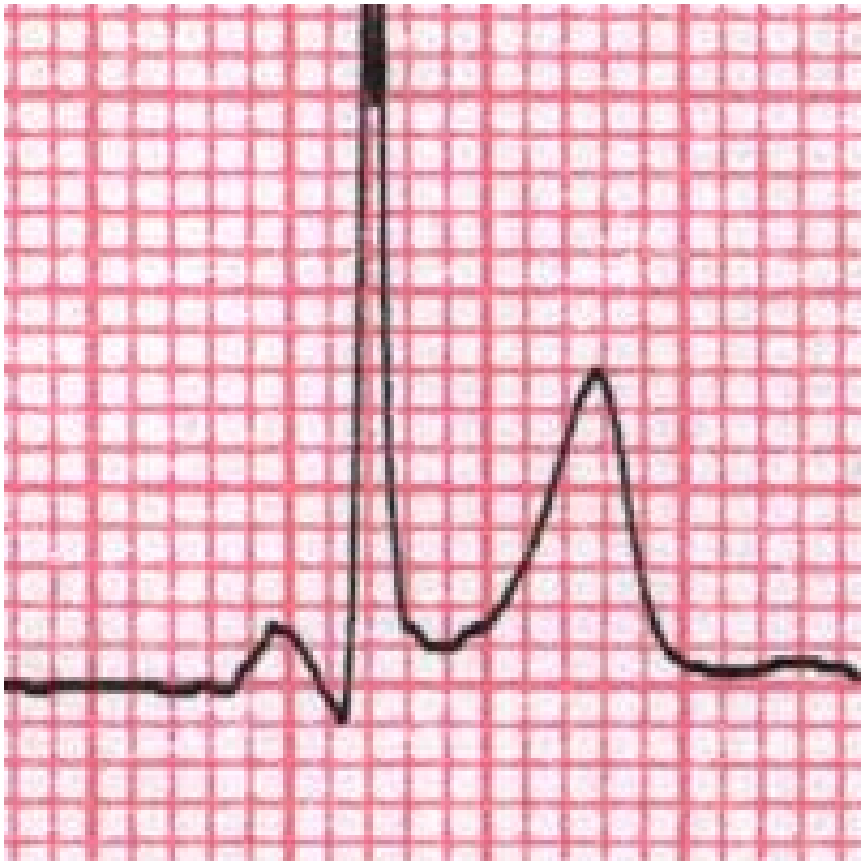
Chronic Cor Pulmonale



Early Repolarization

- Form of myocardial repolarization in which the ST segment is elevated or depressed 1-3 mm above or below baseline
- ECG characteristics:
  - Abnormal Q waves usually absent
  - T waves usually normal
  - ST segment is elevated or depressed 1-3 mm above or below baseline

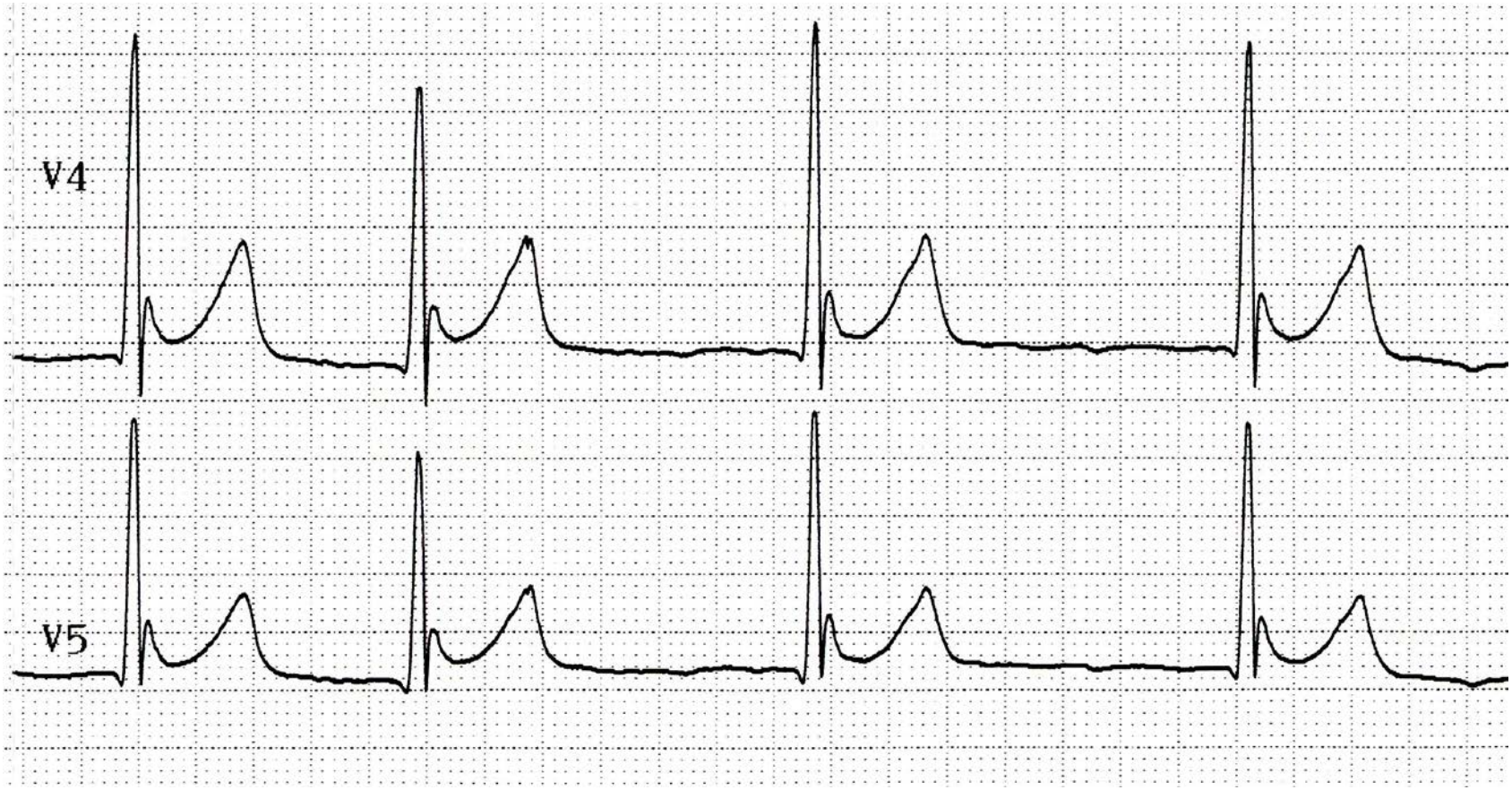
Early Repolarization



Hypothermia

- Distinctive narrow, positive wave, the Osborn wave (J wave), occurs at junction of QRS and ST segment
- ECG changes:
  - Prolonged PR and QT intervals
  - Widened QRS
- Sinus bradycardia and junctional and ventricular dysrhythmias also occur

Hypothermia



Preexcitation Syndromes

- 3 major accessory conduction pathways:
  - Accessory AV pathways – Bundles of Kent
    - Shortened PR intervals
    - Longer QRS duration and abnormally shaped, with delta wave
  - Atrios-His fibers – James fibers
    - Shortened PR intervals
    - Normal QRS
    - No delta waves
  - Nodoventricular/fasciculoventricular fibers – Mahaim fibers
    - Normal PR intervals
    - Longer QRS duration and abnormally shaped, with delta wave

Preexcitation Syndromes

Preexcitation Syndrome

P Wave	PR Interval (in seconds)	QRS (in seconds)	Characteristics
Before each QRS, identical	<.12	Usually >.10	Delta wave distorts QRS

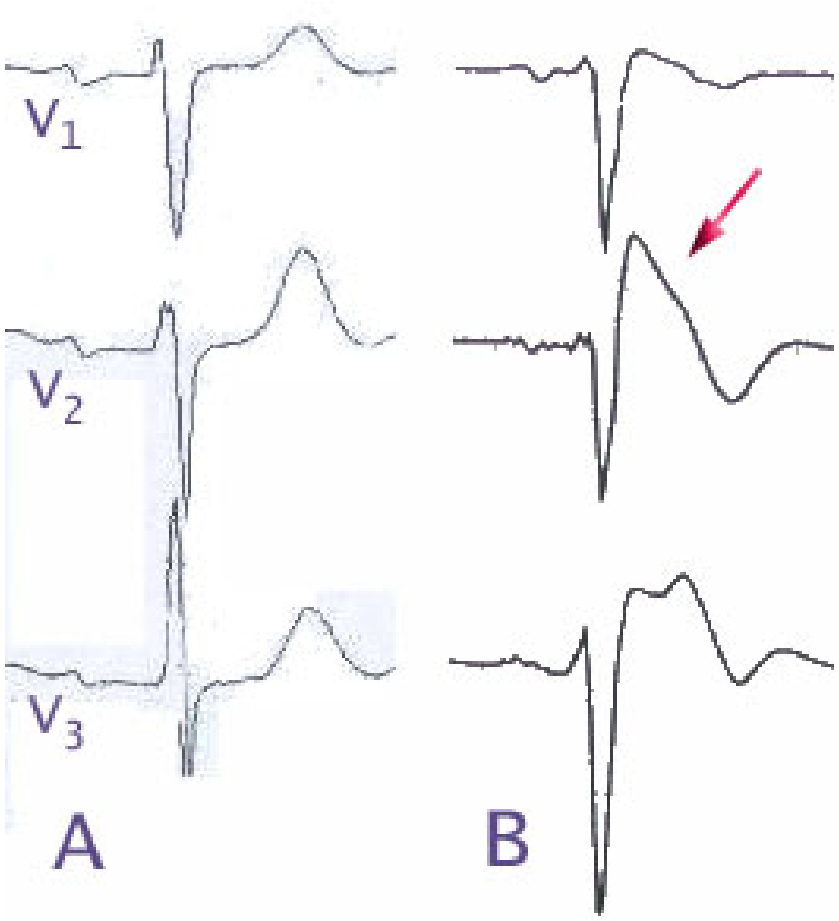
Brugada Syndrome

- Presents with:
  - ST segment elevation in right precordial leads
  - Right bundle branch block
  - Susceptibility to ventricular tachydysrhythmias
  - Structurally normal hearts
  - High rate of sudden cardiac arrest
- More prevalent in Far Eastern countries
- Typical dysrhythmia is rapid polymorphic V tach that frequently degenerates to V Fib
- Increased propensity to A Fib

Brugada Syndrome

- Cardiac events occur during sleep or at rest
- Triggers for some patients:
  - Fever
  - Tricyclic antidepressant usage
  - Cocaine consumption
- ECG characteristics:
  - QRS in V1-V3 resemble right bundle branch block
  - ST segments associated with abnormal QRS in precordial leads have a nonischemic elevation pattern

Brugada Syndrome



Left: Normal ECG

Right: Changes in Brugada Syndrome

Reference

- Wesley, K. (2011). *Huszar's Basic Dysrhythmias and Acute Coronary Syndromes: Interpretation and Management, 4th Edition.* St. Louis: Elsevier.