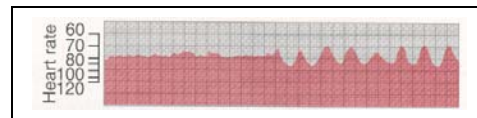
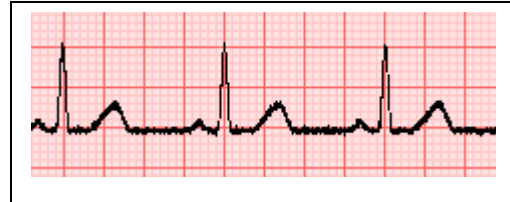


Sinus Rhythms

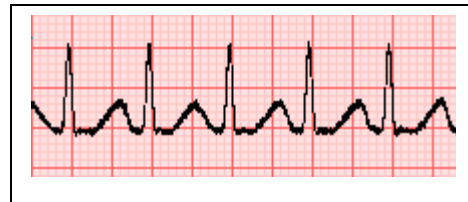
Normal sinus arrhythmia

- Small, slow variation of the R-R interval
- i.e. variation of the normal sinus heart rate with respiration, etc.



Sinus Tachycardia

- Defined as sinus rhythm with a rate > 100 beats per minute (BPM)
- QT interval decreases as the rate increases. Normally $QT < 40\%$ of RR interval.
- Maximum heart rate in sinus rhythm is usually $(220 - \text{age})$ BPM



Sinus Bradycardia

- Defined as sinus rhythm with a rate < 60 BPM
- May be due to parasympathetic dominance at rest (i.e. “vagal tone”).
- Normal resting heart rate in trained athletes is often in this range.



Step by step approach to EKG rhythm interpretation:

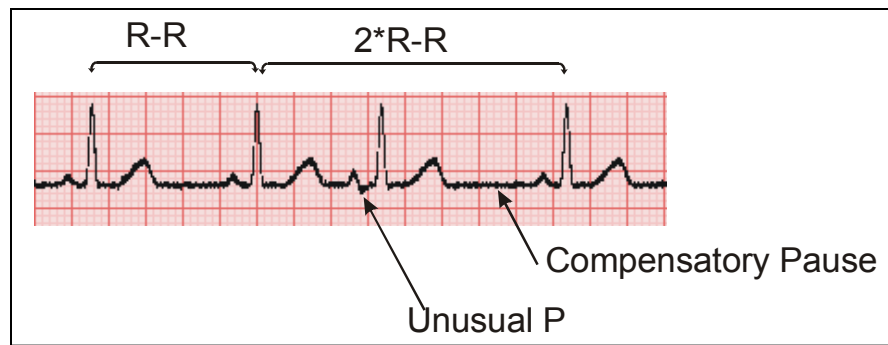
- 1) Is there a P wave associated with each QRS?
- 2) What is the PR interval (is it constant)?
- 3) Is the QRS duration normal (< 0.12 sec)?
- 4) What is the ventricular rate (is the R to R interval constant)?

Premature Beats

Common occurrences in most individuals. Premature ventricular complexes are observed in 60% of healthy adults in 24 hour monitoring. However, these can also result from disease or toxic conditions, i.e. ischemia, infection, inflammation, drug toxicity, overstimulation with sympathetic drugs, electrolyte imbalances, or even excessive use of tobacco, caffeine, or alcohol.

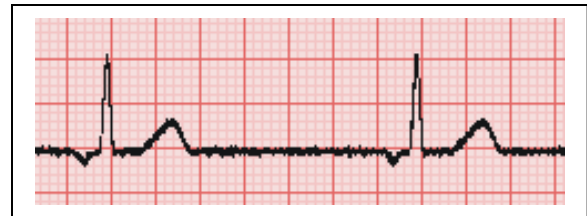
Atrial

- Stimulation by an atrial cell before the SA node action potential fires.
- Often gives rise to an atypical P wave
- Next beat often has a compensatory pause, so that the interval between the previous and subsequent beats is twice the normal R-R timing.
- PR interval normal, QRS normal.



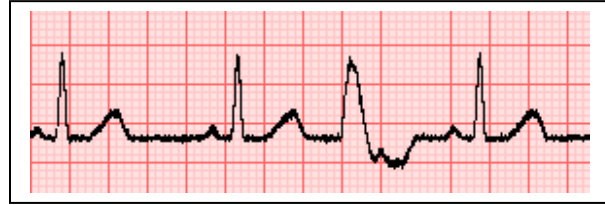
Junctional

- Stimulation by an AV junction cell before the SA node action potential fires. If the junction fires regularly ahead of the SA node, a junctional rhythm (shown below) can occur.
- Atria stimulated in reverse direction – inverted P wave.
- Normal QRS (ventricles stimulated via normal pathway).
- P wave may be simultaneous with QRS or may even follow.



Ventricular

- Stimulation by a ventricular cell before normal sinus stimulation reaches ventricles.
- Propagates through muscle, not Purkinje system.
- QRS duration is prolonged (i.e. “Wide QRS”, > 0.12 s).
- QRS shape usually very different from normal (may be much larger).
- T wave usually inverted.



Tachyarrhythmias

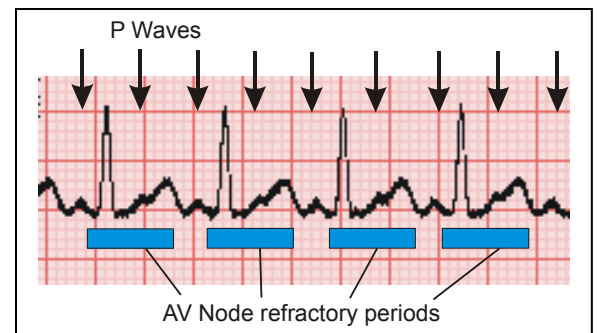
Tachyarrhythmias are abnormal conditions associated with a heart rate of at least 100 BPM, outside of the normal sinus control of rhythm. In general such tachyarrhythmias are segregated into two major classes – Narrow Complex Rhythms, and Wide Complex Rhythms, referring to the duration and shape of the QRS complex.

Narrow Complex arrhythmias are associated with alteration within or above the AV junction, whereas Wide Complex rhythms are generated within the ventricular muscle itself. These two categories are discussed separately below.

Supraventricular Tachycardia (SVT)

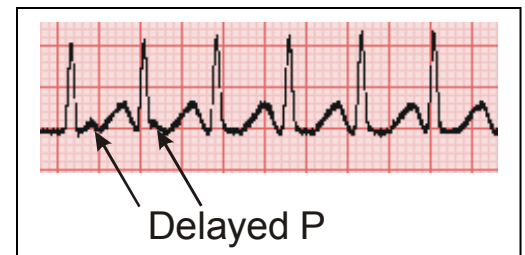
Paroxysmal Atrial Tachycardia

- A single area of the atria becomes “irritated”, generating action potentials at > 150 BPM.
- P waves may have atypical form due to altered pattern of atrial activation.
- AV junction may fail to conduct every atrial action potential.
- Ventricular rate of 100-200 BPM
- PQ interval often normal, QRS normal width.



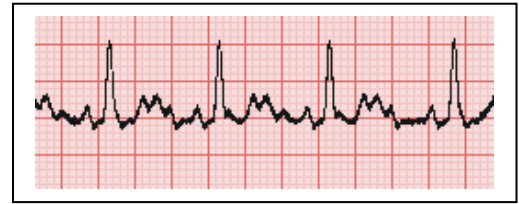
Paroxysmal Junctional Tachycardia

- Fast and slow pathways into the AV junction cause a reentrant rhythm at > 150 BPM
- Stimulates ventricles with normal conduction pathway; normal QRS complex.
- Ventricular rate of 150-250 BPM
- Normal QRS, regular RR intervals.
- P waves may be inverted. May be buried within QRS or may follow it.



Atrial Flutter

- A circular pattern of re-excitation (reentry) circling one atria.
- Regular P waves at >250 per minute.
- Sawtooth pattern of activation on entire baseline.
- AV junction fails to conduct every atrial action potential
- Ventricular rate of 120-150 BPM
- Normal QRS, RR intervals may be regular or reflect varying degrees of AV block.



Atrial Fibrillation

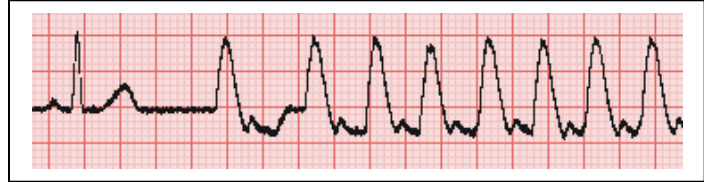
- Most common sustained arrhythmia, affecting as many as 10% of those over 75 yrs.
- Multiple etiologies, including stimulant toxicity, endocrine disorders, myocardial disease, infarct, etc.
- Irregular or chaotic excitation of atria due to multiple reentrant loops.
- Atria do not beat (no coordinated contraction). May lead to blood clot formation within atria.
- No regular P waves.
- Noise superimpose on entire baseline.
- AV junction fails to conduct every atrial action potential
- Ventricular rate of 100-150 BPM
- Normal QRS, irregular RR intervals



Wide Complex Tachycardias:

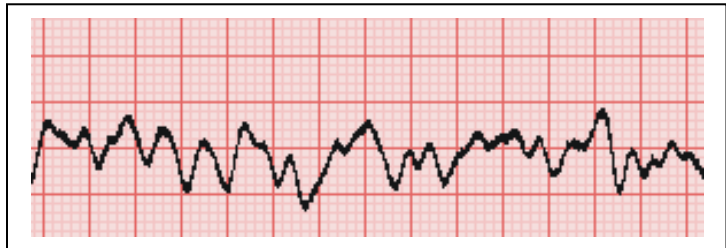
Ventricular Tachycardia

- Most frequent life-threatening arrhythmia
- Due to irritated focus of activity within ventricular tissues.
- Defined as a series of three or more wide-QRS complexes. Rate can be between 100 and 250 BPM.
- T waves inverted.
- Found in ventricular ischemia, infectious or inflammatory conditions, or with congenital defects (e.g. Long-QT).
- VT may degrade into fibrillation.



Ventricular Fibrillation

- Rapid, uncoordinated activation of ventricles from multiple sites.
- Disorganized mechanical activation, loss of pumping action, hemodynamic collapse, and sudden death.
- Caused by ischemia, infectious or inflammatory conditions, structural abnormalities (e.g. hypertrophy) or in reaction to drugs or toxins.
- Requires direct current cardioversion to reverse



Blocks

SA node dysfunction with Junctional Escape

- Sinus Block is a temporary failure to stimulate for at least one cycle.
- Sinus usually resumes pacing with same timing as previous rhythm.
- A long pause may elicit an escape beat from a lower site (i.e. AV-junction).

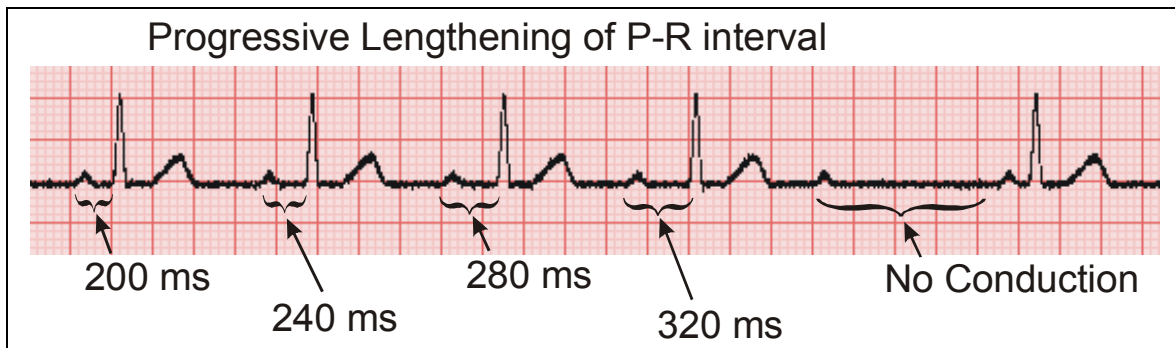
1° AV Blockade

- An increased conduction delay in the AV node (but no real block).
- PR interval > 200 ms.
- Usually asymptomatic.
- May be caused by ischemia, drugs, electrolyte imbalance, vagal tone.



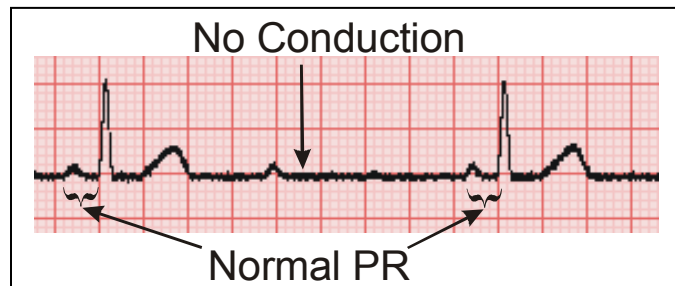
2° AV Blockade: Mobitz I

- Also called Wenckebach Block.
- Characterized by a progressively increasing PR interval, which eventually becomes so long that one cycle fails to stimulate the ventricles. The cycle repeats.
- Similar etiology as for first degree block. Usually benign, does not progress to third degree block.



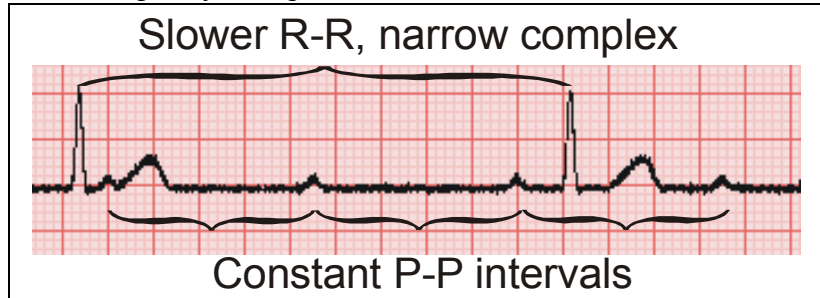
2° AV Blockade: Mobitz II

- Occasional block with constant PR interval in preceding beats.
- Normal P wave at expected time, but no QRS follows.
- Usually due to a block within the His Bundle, may be associated with bundle branch blocks.
- Portends the development of complete (third degree) AV block.



3° AV Blockade

- Complete failure of conduction from atria to ventricles.
- P waves and QRS fully dissociated, with different P-P and R-R intervals.
- Junctional or Bundle of His escape rhythms pace heart at 40-60 BPM when block is high. QRS is narrow.
- Ventricular escape rhythms pace heart when block is below the Bundle of His. Rate 20-40 BPM. QRS is wide (as in a premature ventricular beat).



Bundle Branch Block (BBB)

- Block of either the right or left excitation bundles that branch from the Bundle of His.
- Excitation spreads to that portion of the heart via conduction through the ventricular muscle.
- In right BBB, right heart activation follows left. In left BBB, left follows right.
- Often associated with wide, double-peaked QRS complexes.
- T-wave often inverted due to altered timing of repolarization.

