EKGs

Simulation Lab
Cardiology Interest Group
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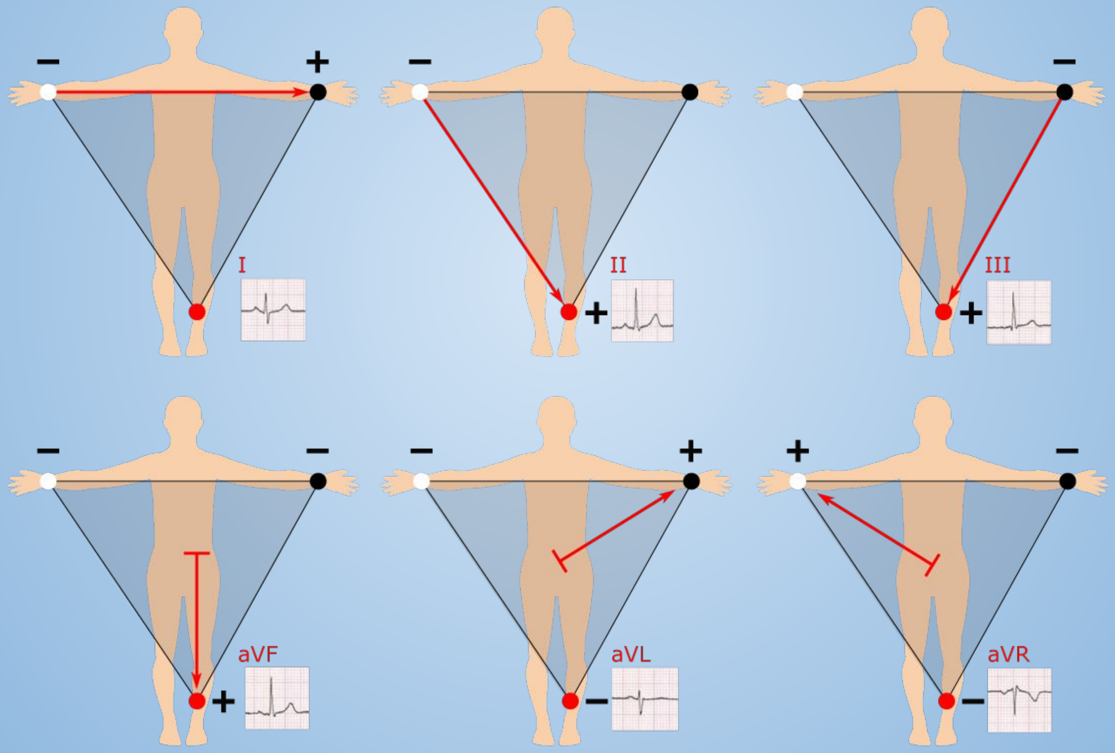
Basics of EKG

- In your heart, you have a bunch of cells that much like neurons, utilize the transport of different ions to conduct a signal (Na and K, Ca for contraction)
- Unlike the signals of the brain (like understanding this information or feeling someone touch you), your heart conducts a signal that functions in contraction
- Together, the net movement of ions responsible for that contraction can be measured in an EKG, which forms vectors based on the net direction and amplitude of said net movement
- Because everything in medicine has to have a name, the components of that waveform are named after the depolarization or repolarization of different parts of the heart, but at times it can feel like an alphabet soup

Basics of EKG

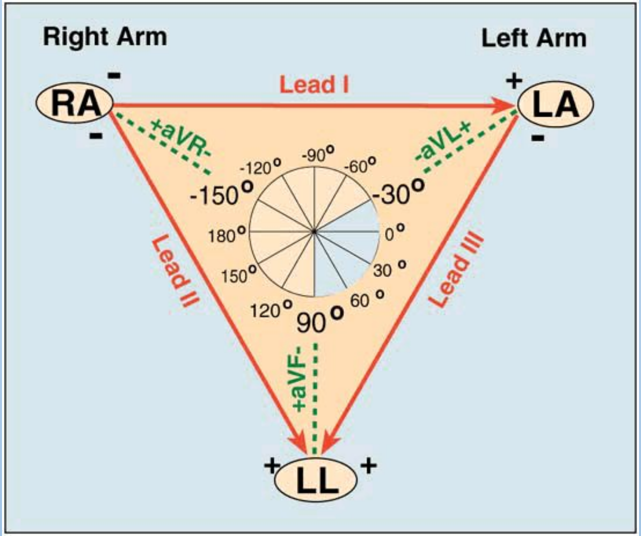
- Different electrical leads are placed on the patient to measure that current. Three limbs are used (R arm, L arm, foot) and are designated in leads aVR, aVL, and aVF respectively.
- Three other leads form an equilateral triangle utilizing the previously placed limb leads. This helps form the basis of a 12 lead EKG (this is done by augmenting the positive or negative charge of the respective limb leads but the details are not as important, as long as you understand this axis that forms from these leads)

Basics of EKG



Basics of EKG

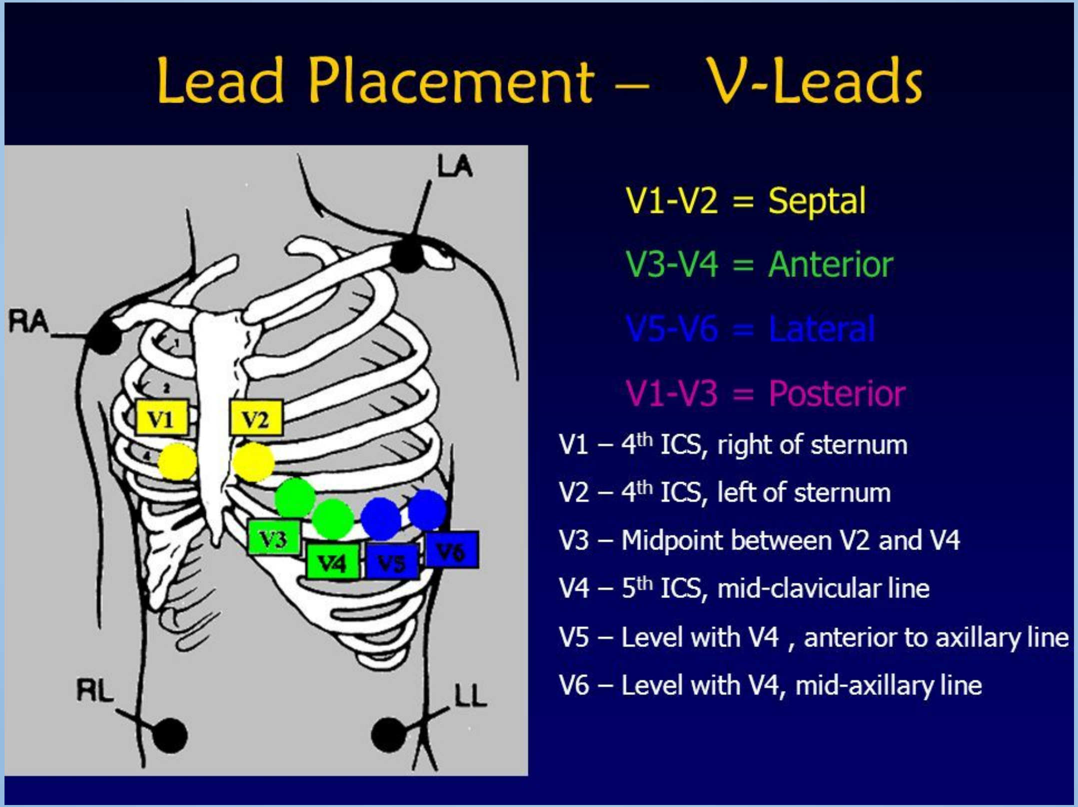
- If you were to place those six previously mentioned leads (aVF, aVR, aVL, I, II, and III) then you can form a circle that represents the direction of currents. It looks a little something like this:



Basics of EKG

- To make the patient feel more uncomfortable, we place septal leads, designated as V1 through V6
- These leads start out measuring the conduction of the right side (V1 is furthest right) and go to the left side (V6 is furthest left)
- These leads give a better idea of conduction and provide a left vs right view of conduction. (Particularly in pediatric patients, looking at V1-V3 can be helpful in looking for RVH and V4-V6 for LVH as they will show huge depolarizations in those respective lead groups)

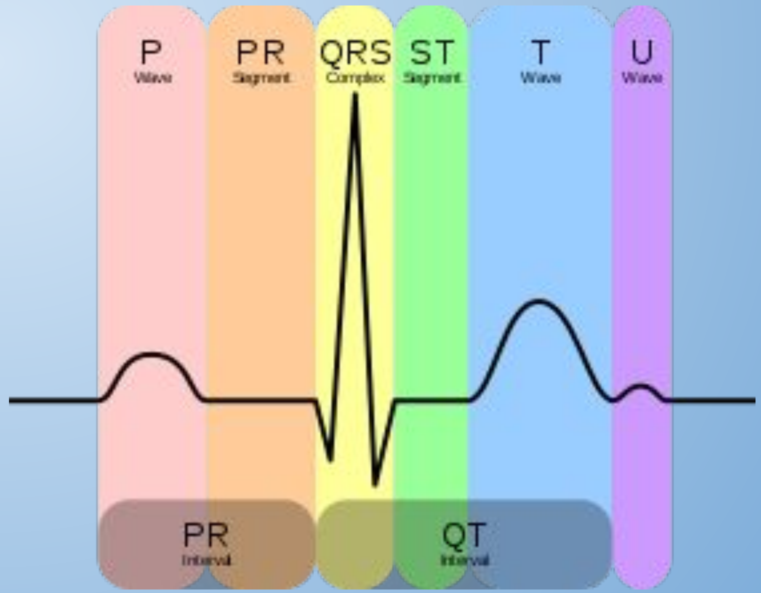
Basics of EKG



Now, let’s take EKGs and we will go through how to read them in a second

Basics of EKG

- This is what a normal EKG tracing looks like.
- P-atrial depolarization
- QRS-ventricular depolarization (atrial repolarization is buried within it)
- T-ventricular repolarization



Basics of EKG

- Remember-EKGs are measuring vectors based on particular lead placement
    - Heart should depolarize from R to L and top to bottom
    - Net current towards something gives an upward deflection, away gives a downward deflection
    - The magnitude of these deflections reflects tissue mass or conduction delays

Basics of EKG

- Dr. Petrany does a great job teaching a systematic way of going through EKGs-rate, rhythm, axis, PR, QRS, ST, QT
    - Now that you know how to place the leads, we will go through how to read them
    - Regardless of which field you go into-you WILL order an EKG on your patient at some point-so know how to read them

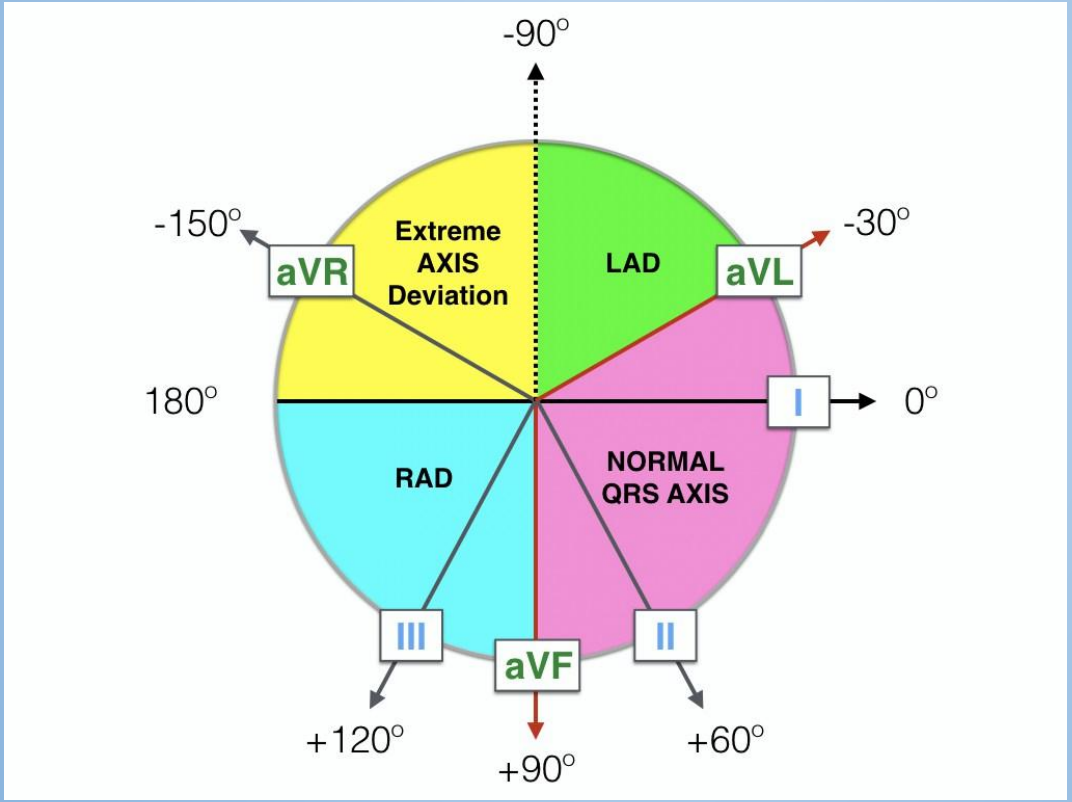
Rate

- Rate 60-100, count off method (300, 150, 100, 75, 60)
  - If they give you a 12 lead with a rhythm strip-x6
  - Higher rates by age in pediatric patients

Rhythm

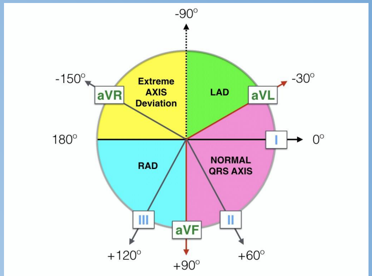
- Normal sinus rhythm is defined differently depending on which attending you are talking to. Some will say it is defined simply as a P before every QRS. Others will go into detail about the P-notably that it is upright where it should be upright (inferior leads like II, III, and aVF) and upside down where it should be (aVR)
  - Sinus arrhythmia is a common rhythm where the P before a QRS and P direction are normal, but the beats are not perfectly on time (if you were to tap your toe or put calipers on the beats, some are slightly closer together and others are slightly further apart). This is a normal rhythm and is particularly common in pediatric patients. It reflects beat variation with respirations

Axis



-90°
-150°
-30°
Extreme
AXIS
Deviation
LAD
aVR
aVL
180°
I
0°
RAD
NORMAL
QRS AXIS
III
aVF
II
+120°
+90°
+60°

Axis



- Axis-normal from -30 to 90
    - Remember that positive currents mean that the net depolarization is going towards that lead
    - Lead I lines up with 0 and aVF lines up with 90
        - If they are both positive you are between 0 and 90
        - If aVF is positive and I is negative you have RAD
        - If I is positive and aVF is negative, you are between 0 and -90
            - To determine if LAD or normal, look at II
            - If II is positive-NAD
            - If II is negative-LAD
    - Another tip from afar-the lead that has the highest upward deflection (highest voltage) is closest to the true axis (for example, if positive in II and aVF but higher amplitude in II, closer to 60 degrees than like 90 degrees

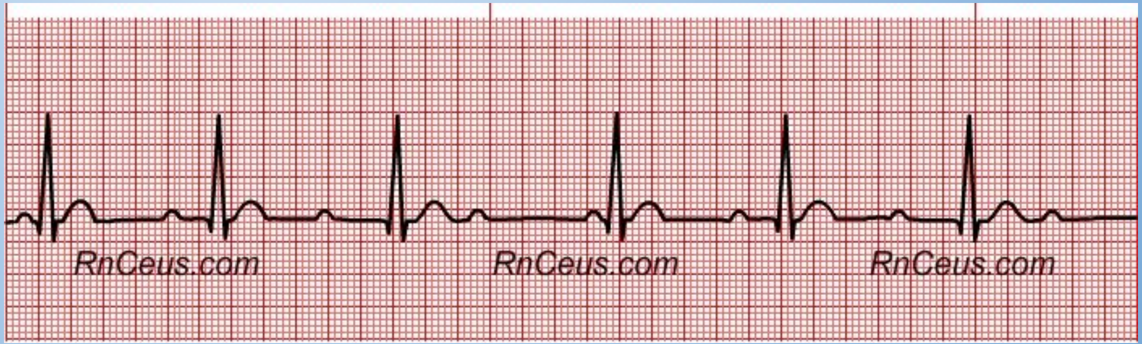
PR Interval

- Atrial depolarization to ventricular depolarization
  - Tells you if the conduction from SA to AV node is working
  - Should be one big box
- Shortened (<.2) in WPW because the Bundle of Kent depolarizes before the conduction from SA to AV occurs
- Prolonged (>.2) in AV Blocks

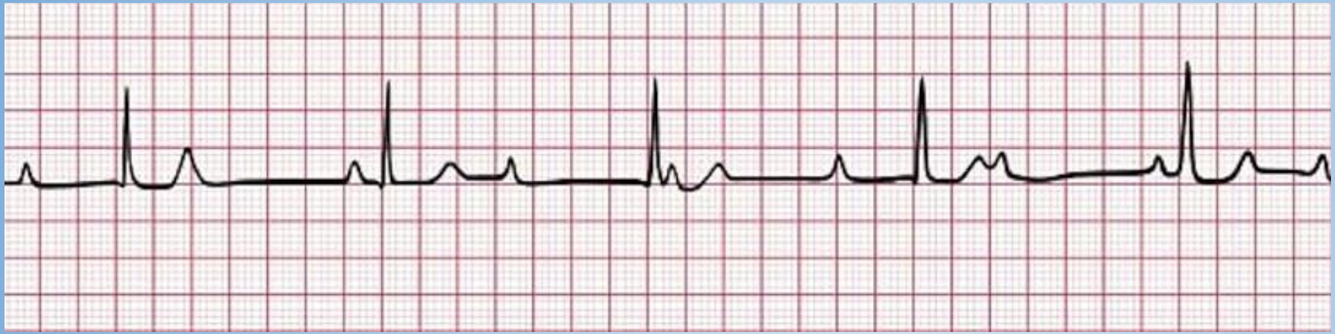
Importance of the PR interval

- Heart Block
  - 1st Degree is no big deal, just a long PR interval
  - 2nd Degree type 1-PR lengthens then drops
  - 2nd Degree type 2-drops a beat without lengthening
  - 3rd Degree-no association with P and QRS

AV Blocks



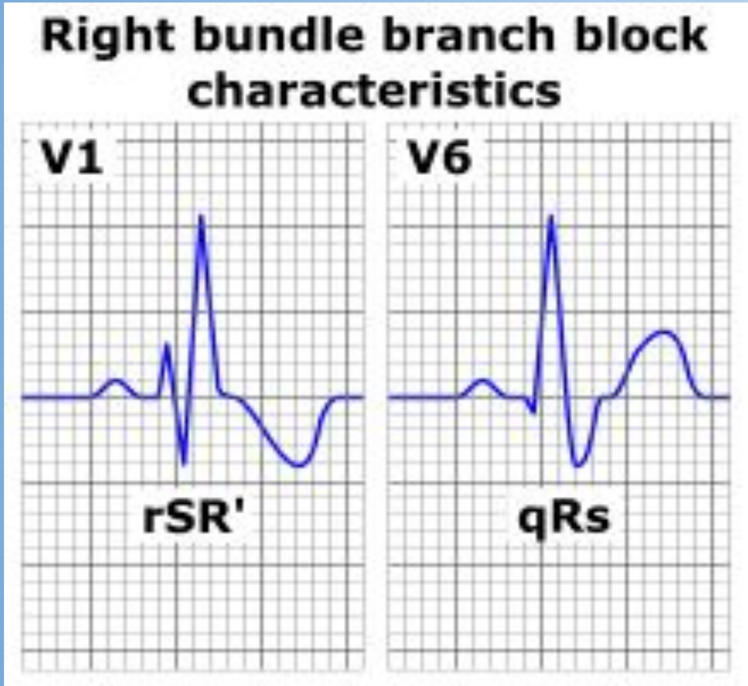
AV Blocks



QRS

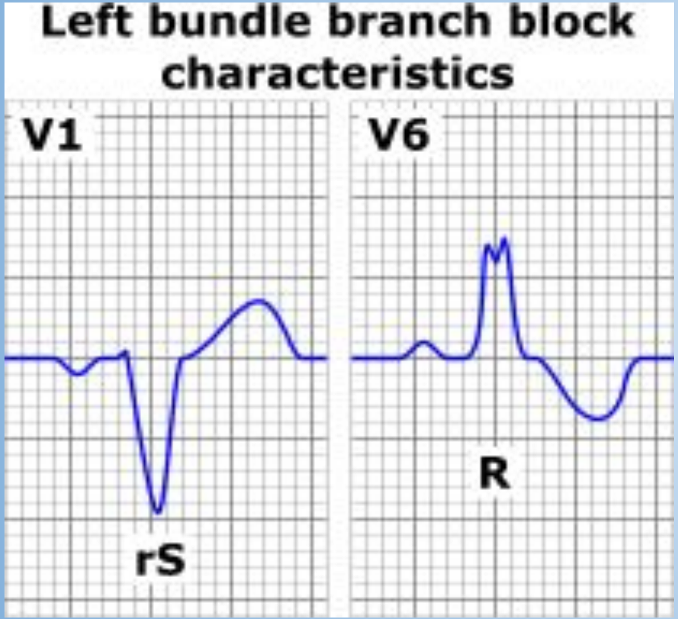
- Back to the rule that normal conduction is the fastest-if the QRS is prolonged that means that the normal conduction pathway is not working
- Recall that the heart depolarizes SA->AV->Bundle of His (RBB and LBB, LBB further splits into anterior and posterior fascicles->Purkinje)
- If the heart is using the normal conduction pathway, the QRS (ventricular depolarization) should be less than .12s
- If the heart cannot use that conduction pathway because there is a block or current is going the wrong direction, it will take >.12s
    - The differential of things that can cause a prolonged QRS are RBBB, LBBB, pacemaker, and WPW

Bundle Branch Blocks-Right



- V1 tells you about the right side of the heart. If the QRS is wide, conduction is not happening in the most efficient way. The characteristic pattern in V1 is rSR' (look for the M pattern)
- The positive upward deflection represents an attempt to conduct, then blocked, and then comes back after depolarizing the left side of the heart first (the net negative).
- It is able to bypass the block after depolarizing the left side of the heart
- The rSR' pattern is normal in children if the QRS is still narrow. Always check the QRS interval before saying hey there is a bundle branch off the wave morphology alone.

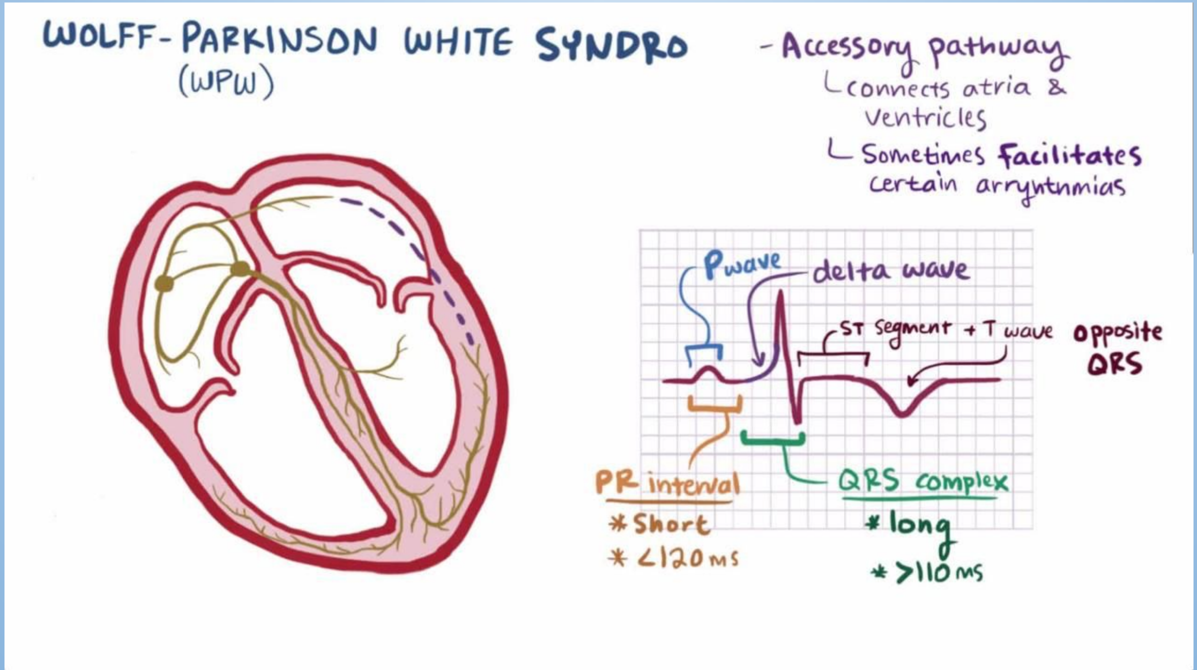
Bundle Branch Block-Left



- V1 shows the right side of the heart.
- If the QRS is wide in V1 and looks like an L, it represents a LBBB
- If you look closely, V1/V6 are opposites of one another with respect to RBBB/LBBB

WPW

Cool morphology of long QRS and short PR because there is an accessory pathway through the Bundle of Kent (form of pre-excitation that sets up SVT-AVRT)



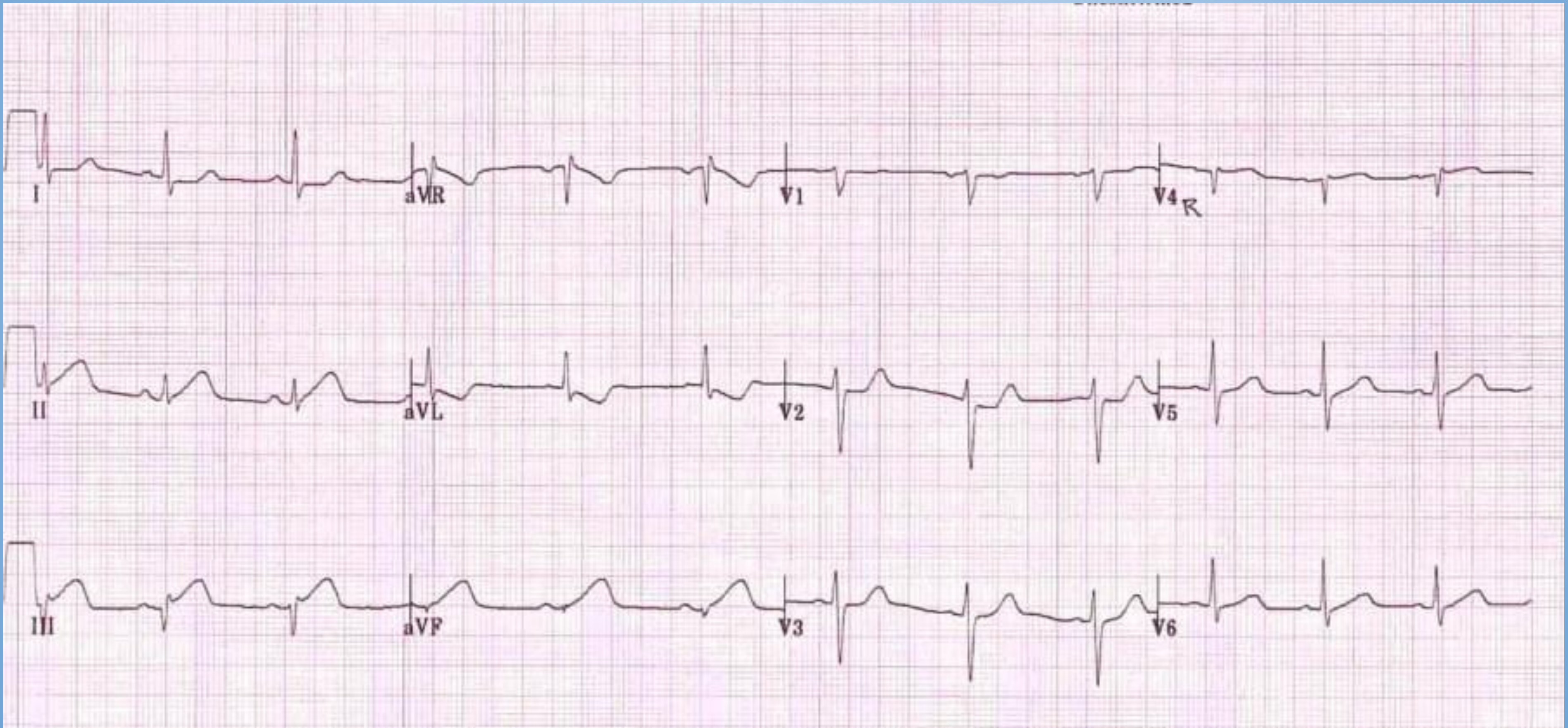
ST

- ST segment will change as a reflection of ischemia and infarction
  - Can only be called if there are reciprocal changes
    - ST depression-ischemia
    - ST elevation-infarction
  - Occurs in group of leads
    - Inferior leads-II, III, aVF
    - Septal-V1-V2
    - Lateral-I, aVL
  - Diffuse STE seen in setting of pericarditis
    - NSAIDS and colchicine

T wave

- T wave inversion is an earlier sign of ischemia
- In surgery, two leads are used to watch for ischemia (II shows right side distribution of RCA, V5 for left side distribution of LAD)
- T wave inversion is normal in adolescents in leads V1-V3

ST

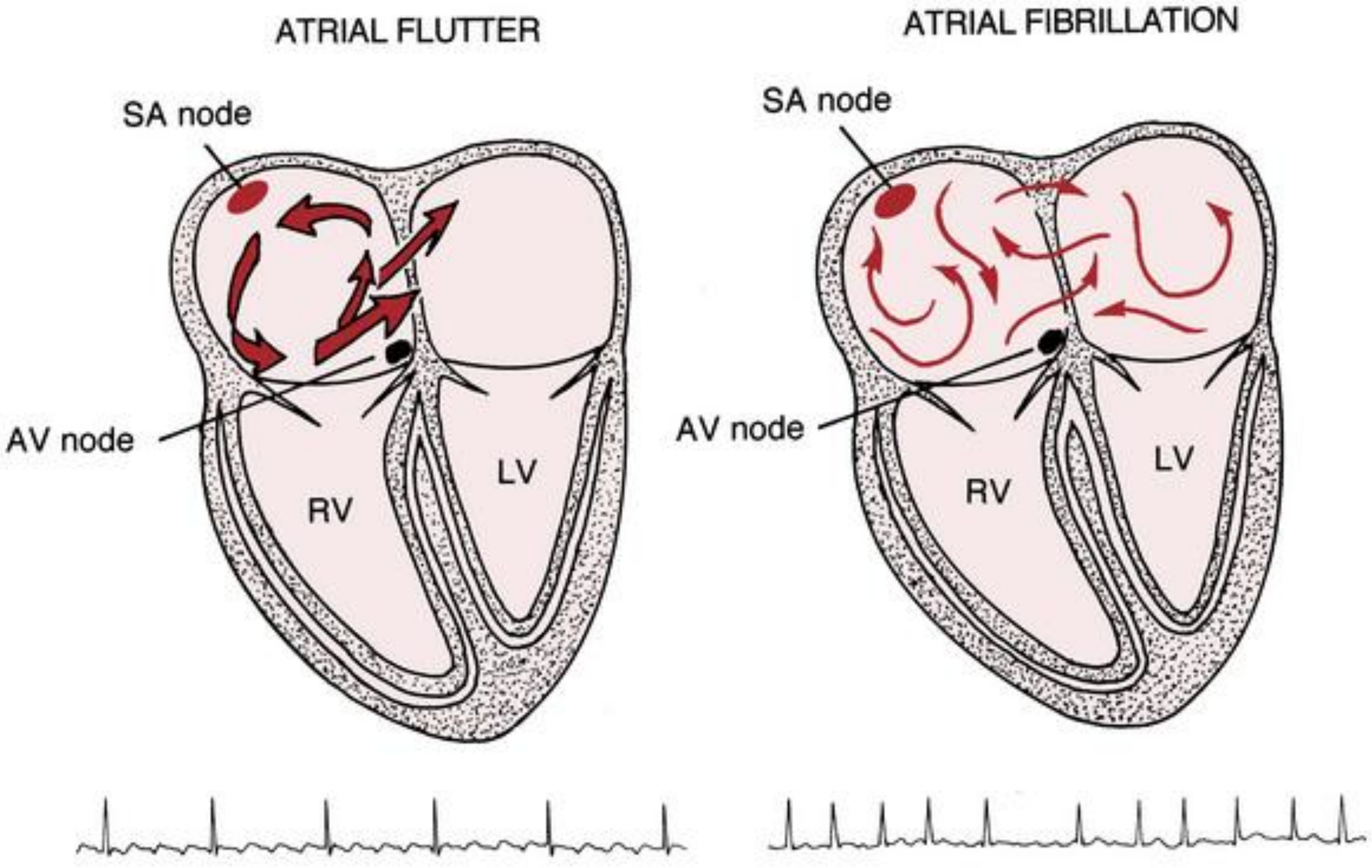


Atrial fibrillation

- Irregularly irregular
  - No p waves
  - Irregular RR intervals
- Cannot get the electrical conduction together, so it just kinda irregularly moves around and thus because it isn’t a uniform signal, it cannot form a p wave, but the signal is able to get through (at varying intervals) to cause the AV node to fire to form QRS

Atrial flutter

- Consistent electrical circuit-but it just isn’t the fastest
- Sawtooth appearance
- Consistent RR interval



ATRIAL FLUTTER
SA node
AV node
RV
LV
ATRIAL FIBRILLATION
SA node
AV node
RV
LV