

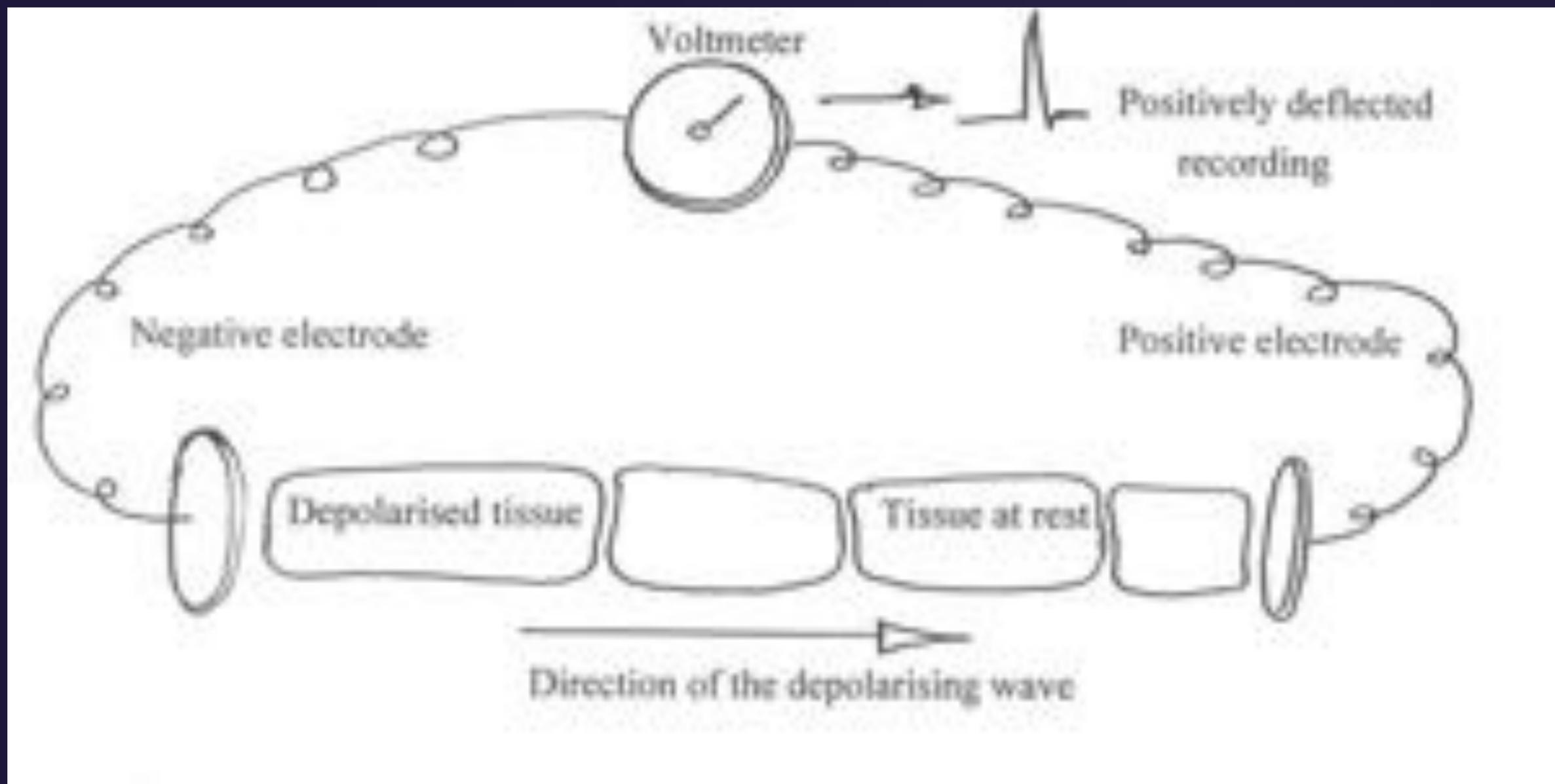
# ECG Workshop

Emergency Medicine &  
Trauma Update 2016

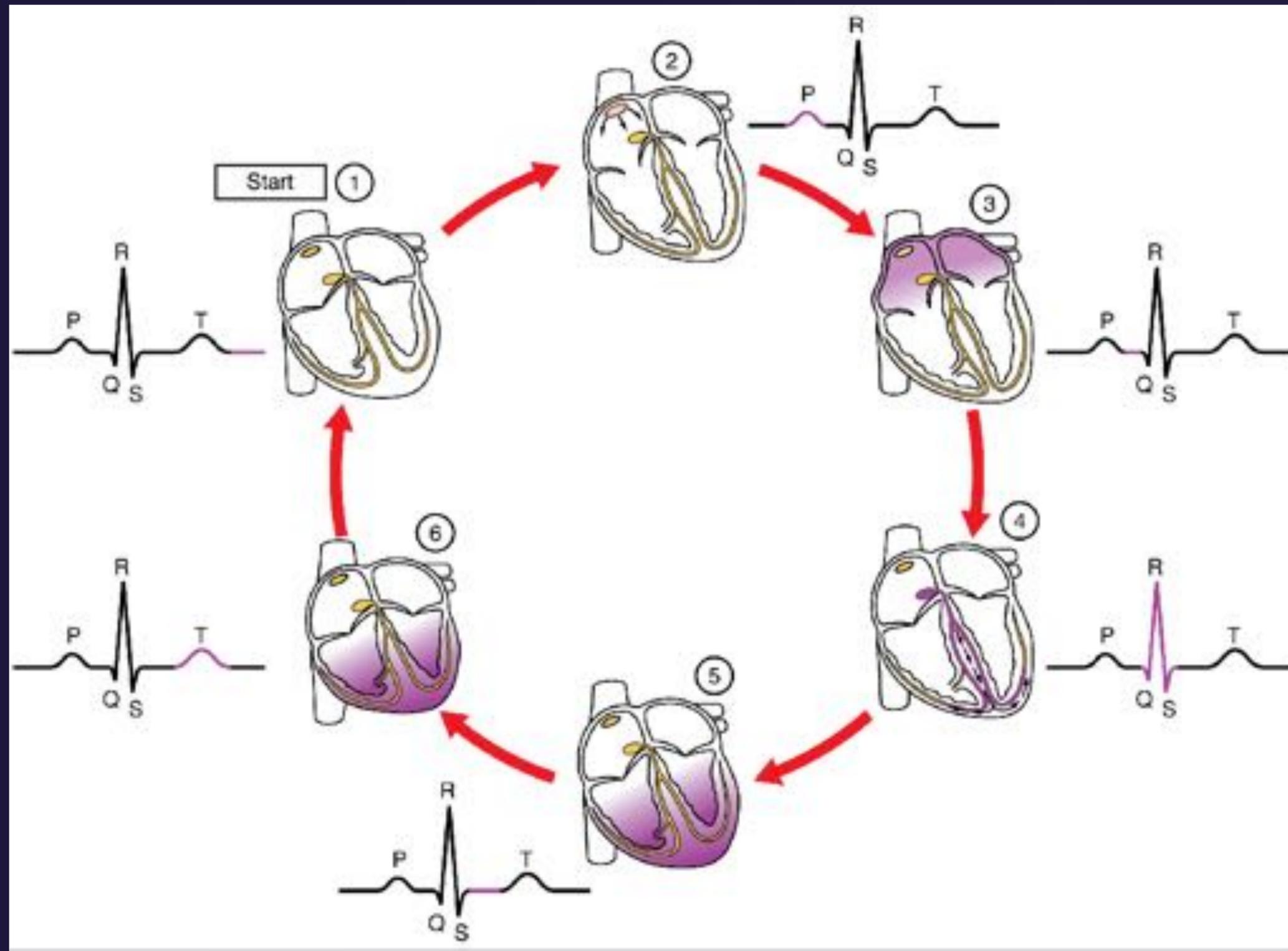
Charles Bruen, MD

[resusreview.com/emtu16](http://resusreview.com/emtu16)





# Mechanical-Electrical Cycle



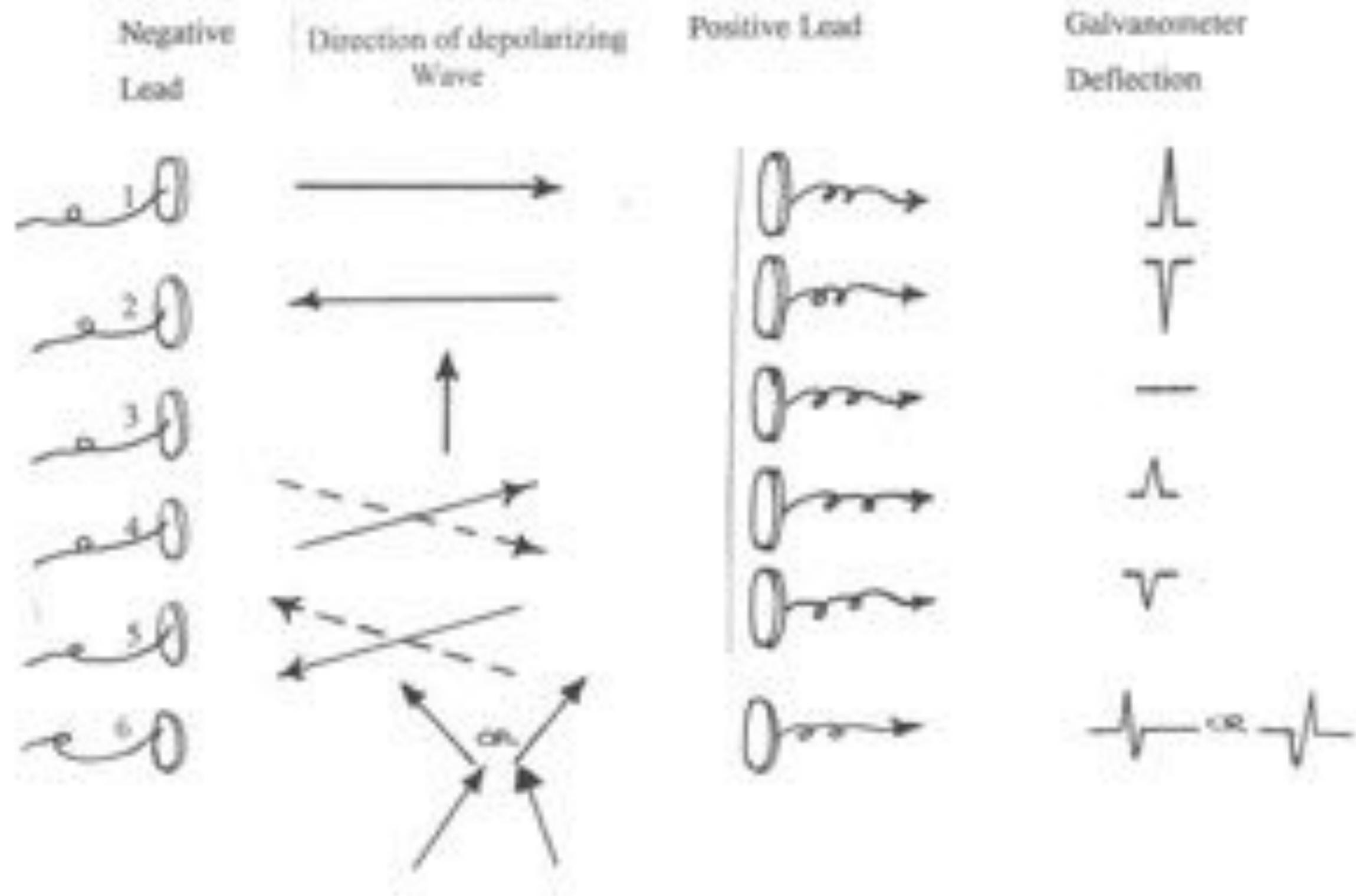
# Leads

- A Lead is a picture
- You cannot point to a wire and say this lead is such...

# Leads

- To measure electrical activity you need at least two electrodes
- One electrode "looking" between itself and the other electrode(s).
- By changing the position of either of these electrodes we alter the angle at which we are viewing any activity.



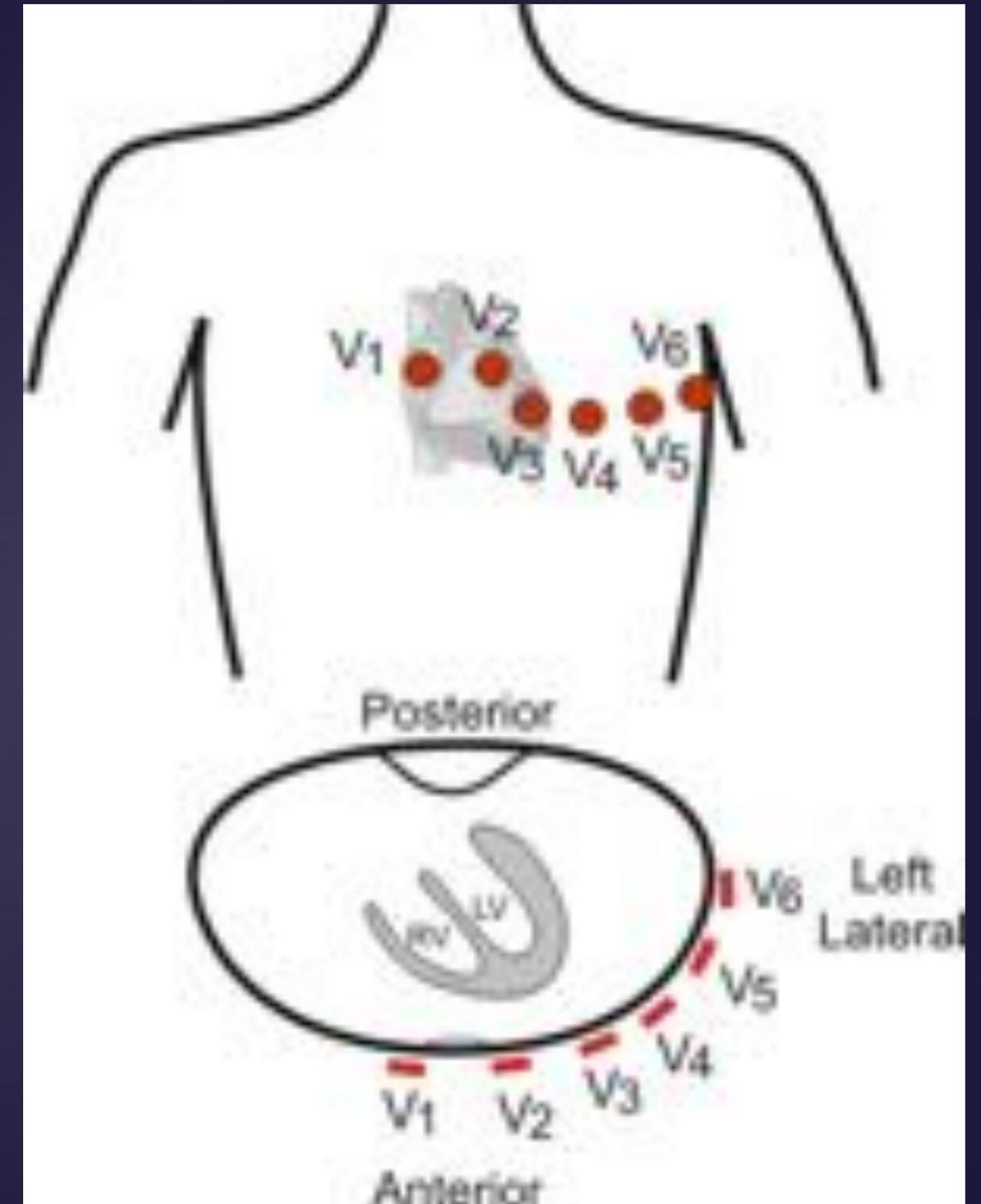


# Leads

- The electrode doing the looking is always a single electrode.
- The "other" could be a single electrode or a number of other electrodes joined together (electrically) to form a reference point.

# Preordial Leads

- E central terminal =  $\frac{1}{3} (EL + ER + EF)$
- Not zero, but mostly constant through cycle
- V exploring electrode =  $E_p - E_{ct}$



# Precordial Lead Placement

- V1 and V2 are placed on the right and left side of sternum at the fourth intercostal space.
- Palpate the suprasternal notch
- Palpate down the manubrium until you feel a horizontal ridge (Angle of Louis)
- Articulates with the second rib. Below the second rib is the second intercostal space.

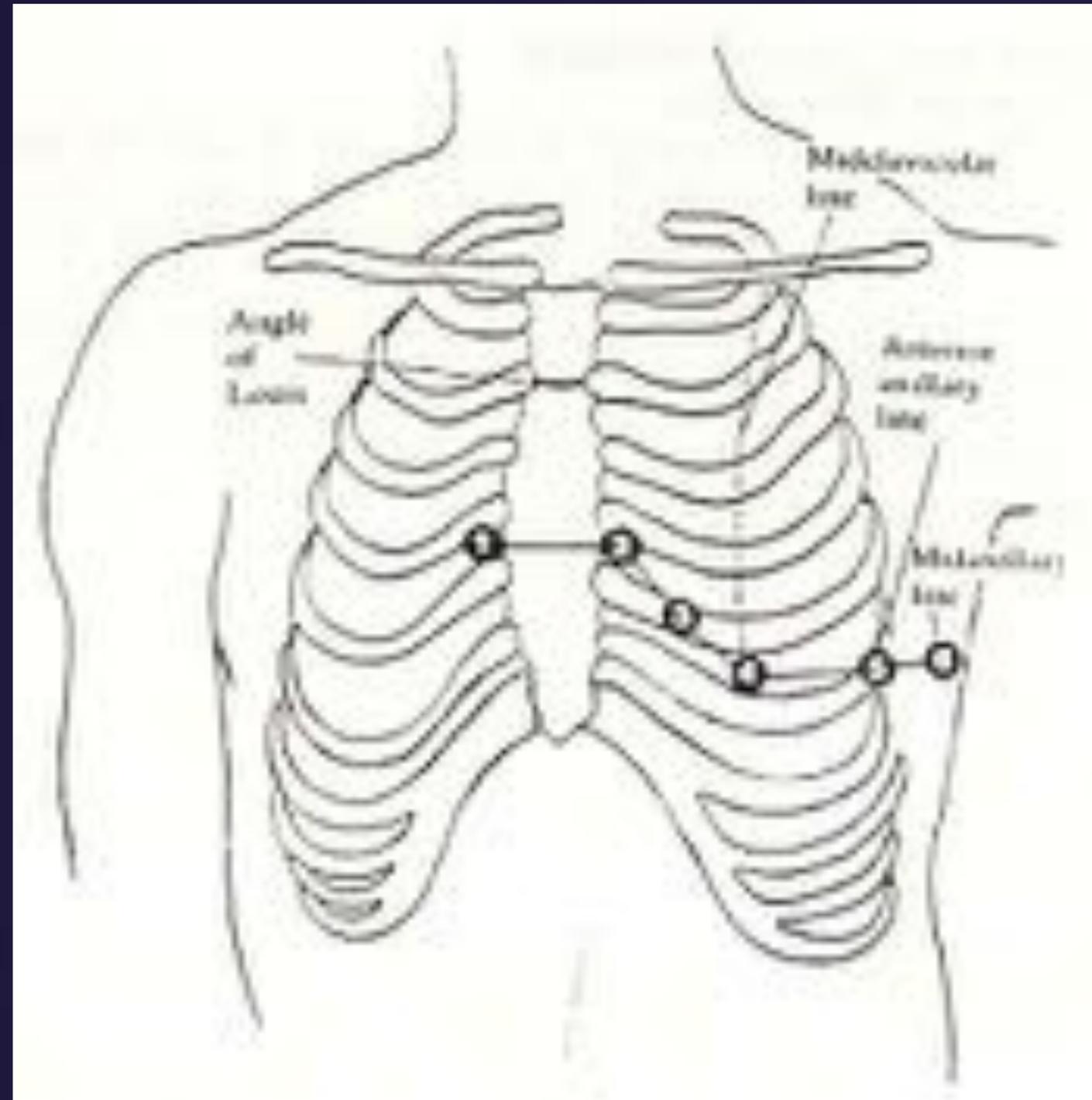
# Precordial Lead Placement

- V1 (right side) and V2 (left side) locations straddle the sternum at 4th intercostal space. No eye-balling.
- V4 is placed in the 5th intercostal space in the mid-clavicular line.
- V5 is placed in a direct line with V4 at the anterior axillary line (front of the armpit).
- V6 is placed in alignment with V4 & V5 at the mid-axillary line (middle of the armpit).
- V3 is placed between V2 and V4.

# Precordial Lead Placement Tips

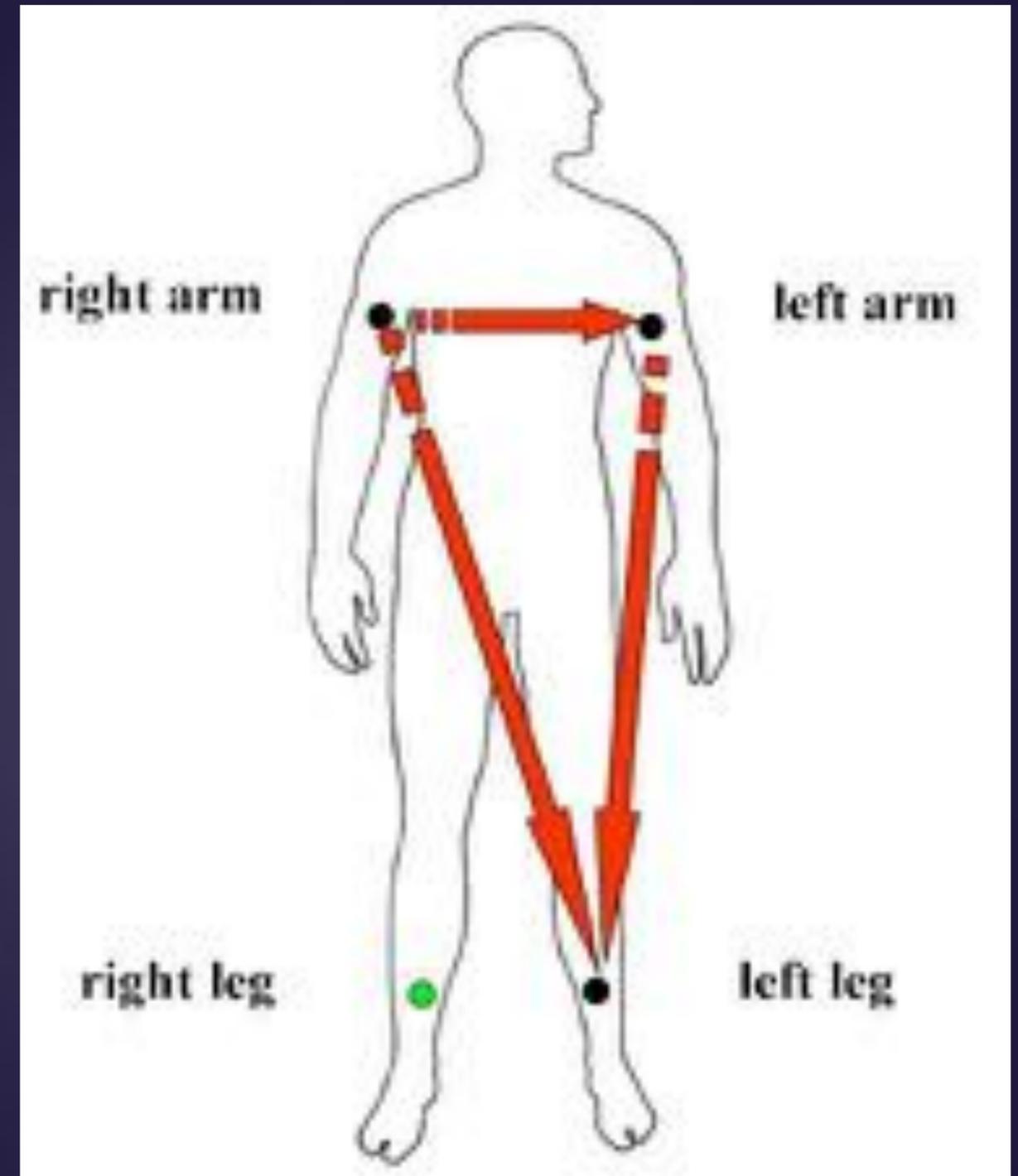
- If the sensors cannot be placed in the usual locations, be sure to document the alternate location and why they were moved i.e. burns, surgical dressings, chest tube etc.
- Elevating the head and gravity may help positioning of large breasts or implants, otherwise under breast.
- If sensor will not lay flat (cleavage), you may need to move the V1 and V2 sensor as high as the second intercostal space.

# Precordial Lead Placement



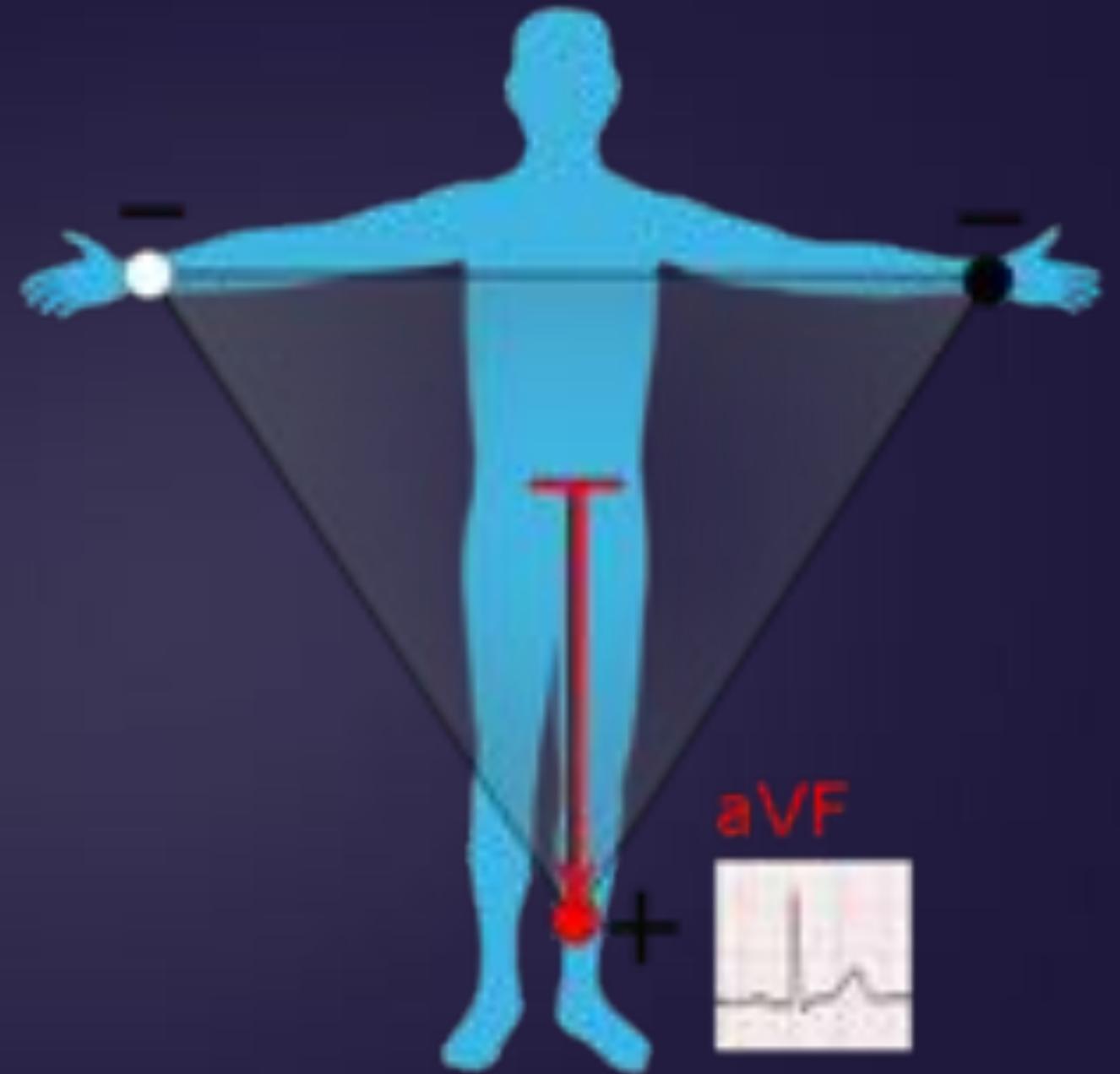
# Limb Leads

- $I = EL - ER$
- $II = EF - ER$
- $III = EF - EL$
- $I + III = II$   
(Einthoven Law)



# Augmented Limb Leads

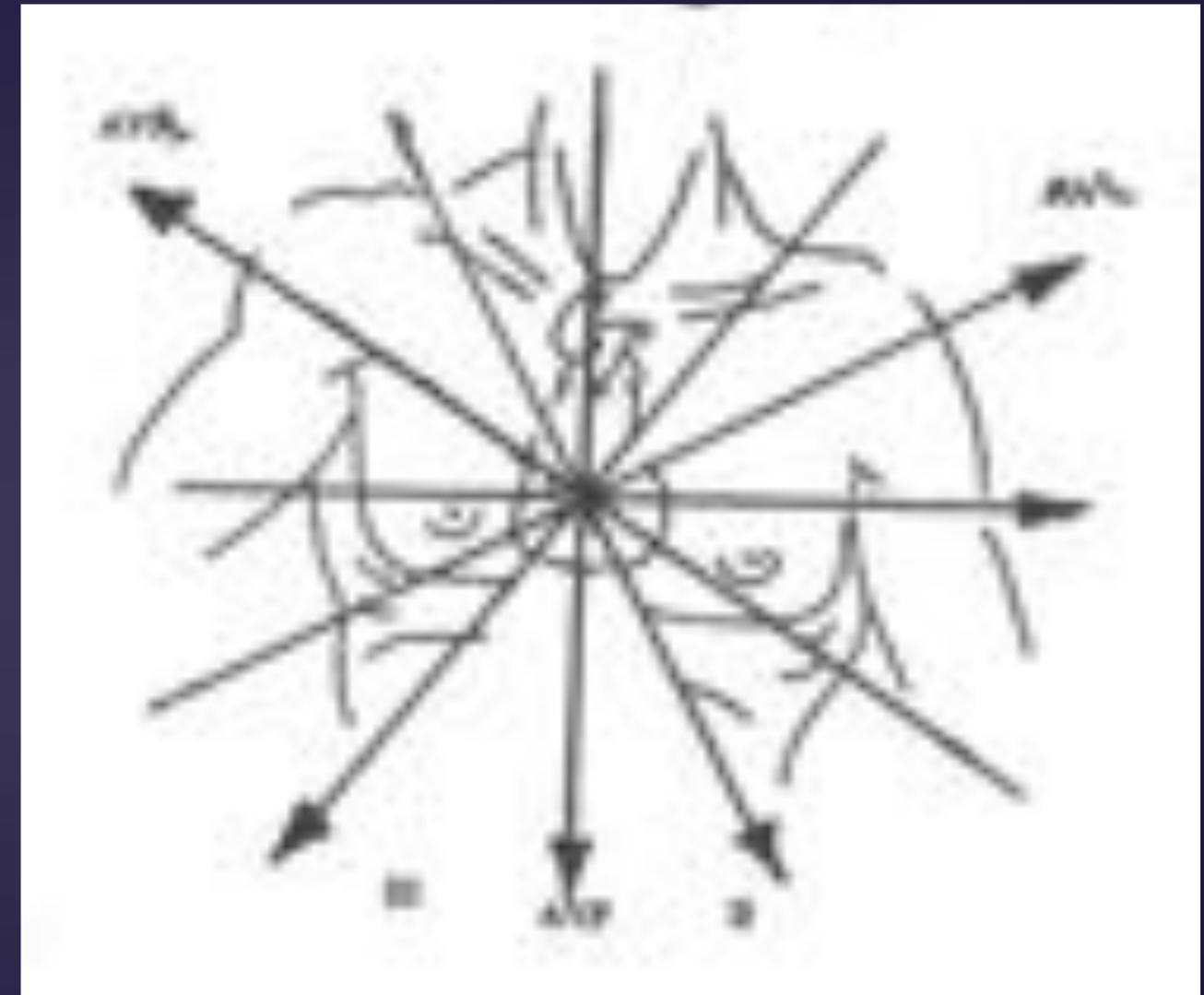
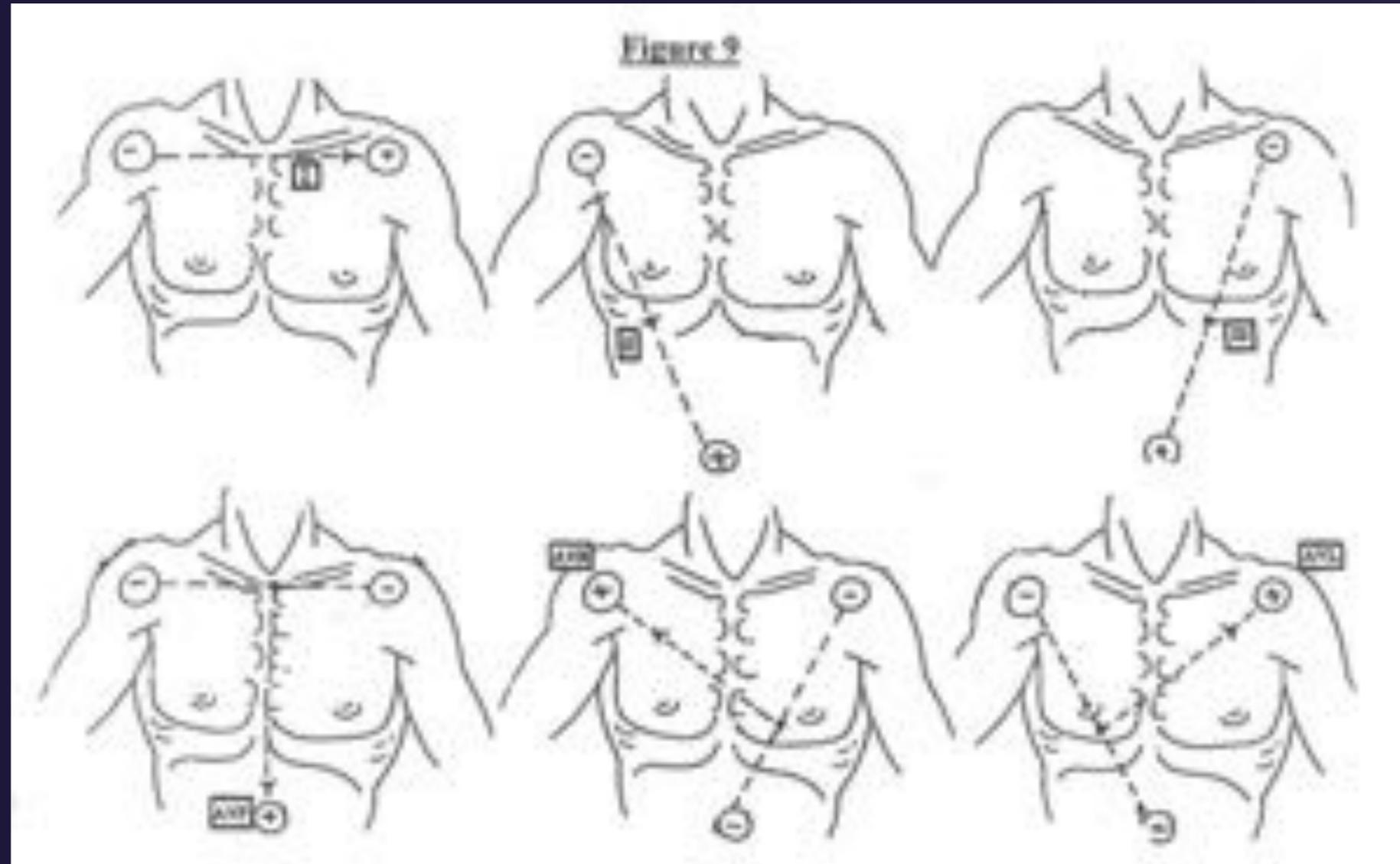
- $aVL = EL - (ER + EF) / 2$
- $aVF = EF - (EL + ER) / 2$
- $aVR = ER - (EL + EF) / 2$
- $aVR + aVL + aVF = 0$



# Limb Lead Placement

- Handwidth above base of the palm. If unable, use the deltoid.
- Handbreadth above medial malleolus. If unable, on the thighs
- Stay away from large muscles due to the potential for movement and increased somatic tremor.
- Symmetry!
- Most important aspect of ecg recording is consistency of recording technique.

# Frontal Plane



# Patient Positioning

- **Supine**
- **Comfortable**
- **Generally no pillows**
- **Barrier between the patient and the side rails (sheet, blanket, pillows or rail pad).**

# Skin Prep

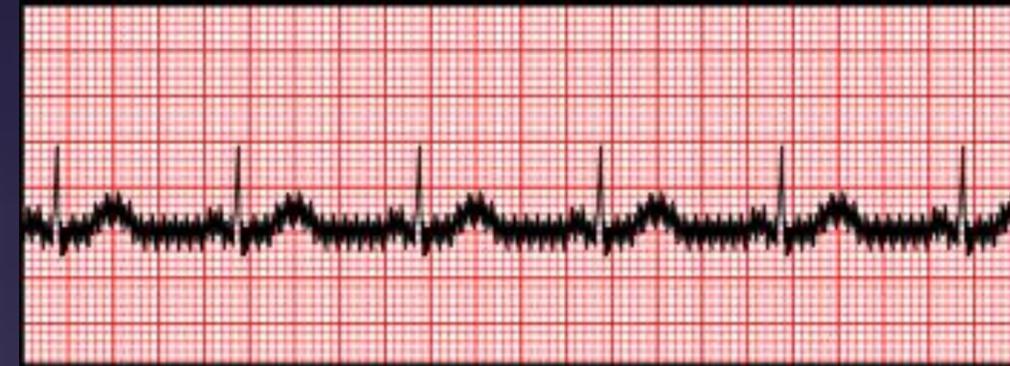
- Prep the skin the alcohol swab to remove dirt, dead skin cells, oils, skin moisturizer, fake tan, body powder, sweat etc.
- Poor prep can cause poor contact with the sensors and artifacts
- Hair may need to be shaved

# Cables

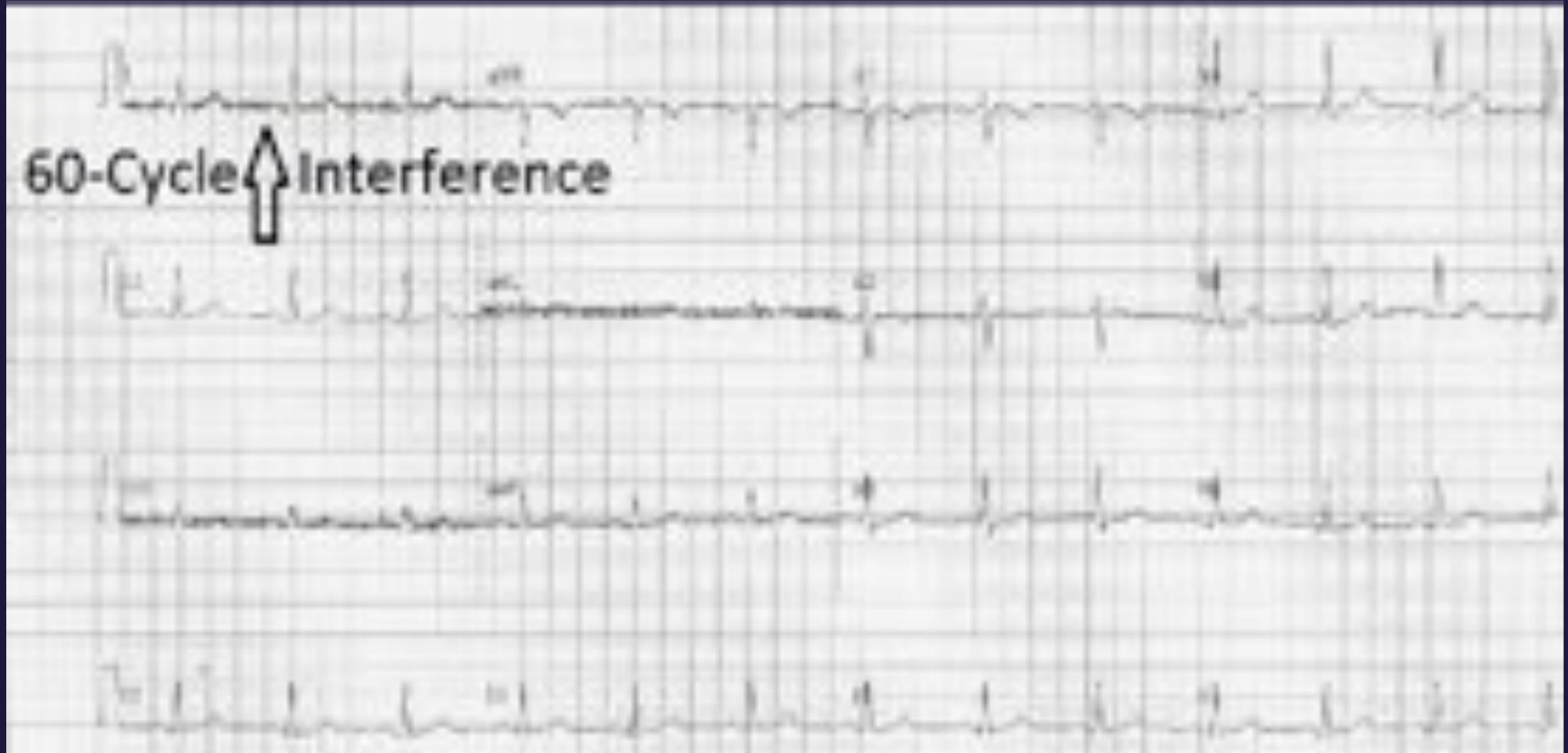
- Run the cables on top of the patient midline.
- Cables must lie flat on the patient, be contained within the body and not put any stress on the sensors.
- Cables that hang off the patient are susceptible to EMI and can be a source of artifact.
- Verify sensors are not peeling up or dimpled

# Electrical Interference

- Tight rapid oscillations seen in the tracing which looks like a caterpillar (thick and fuzzy)
- 60-cycle AC or RF interference
- May be caused by power cords, mobile phones, lighting or electrical wires in the walls, ceiling and floor.
- Turn off lights, mobile phones off, moving away from walls and equipment, verify AC filter is ON



# Electrical Interference



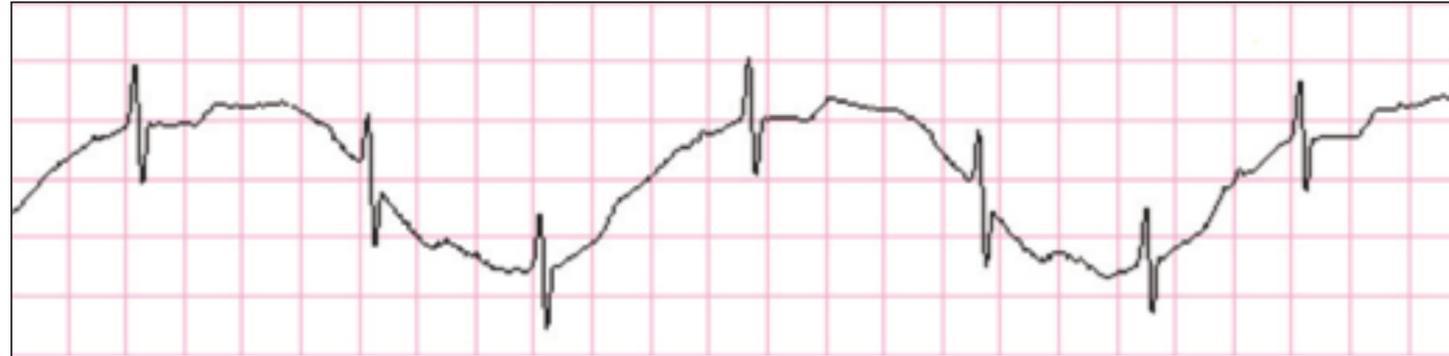
# Wandering Baseline

- Isoelectric line changes position

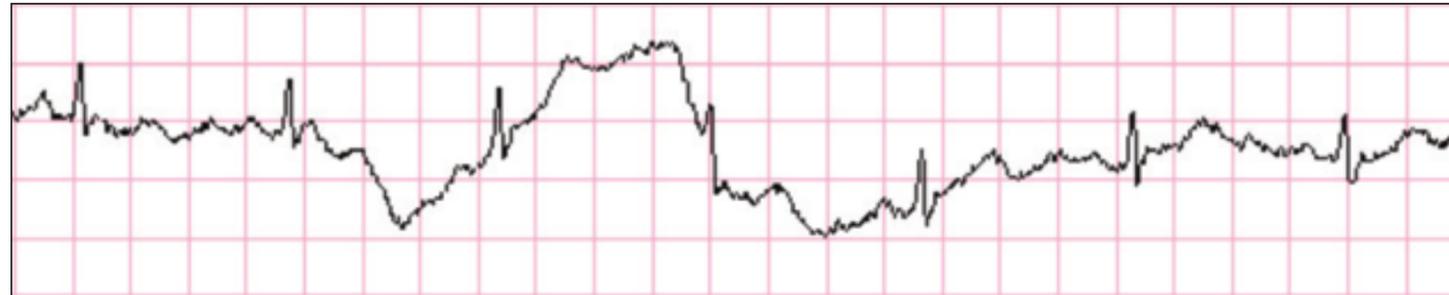


# Wandering Baseline

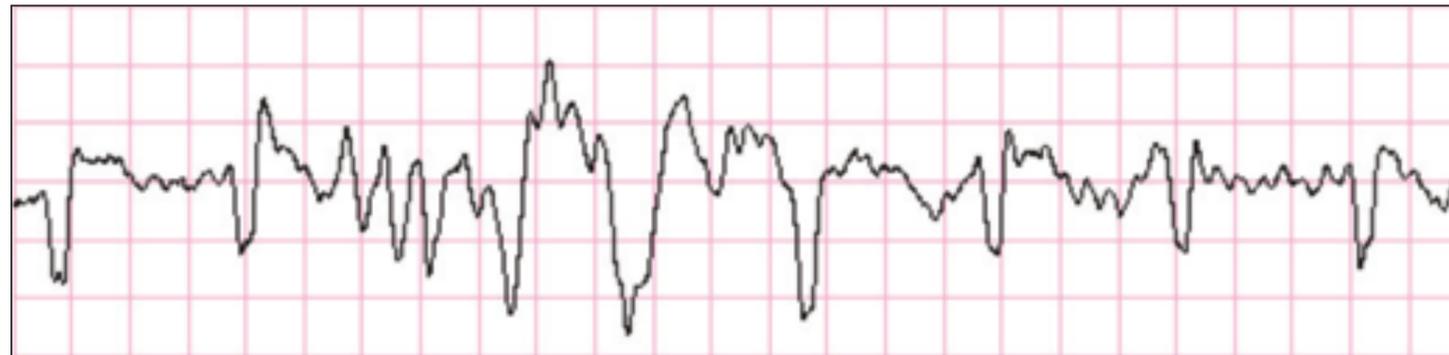
**Respiration:** Low frequency (0.4–2 Hz)



**Patient Movement:** Low frequency (1–3 Hz)



**Transport:** Medium frequency (3–15 Hz)



# Wandering Baseline

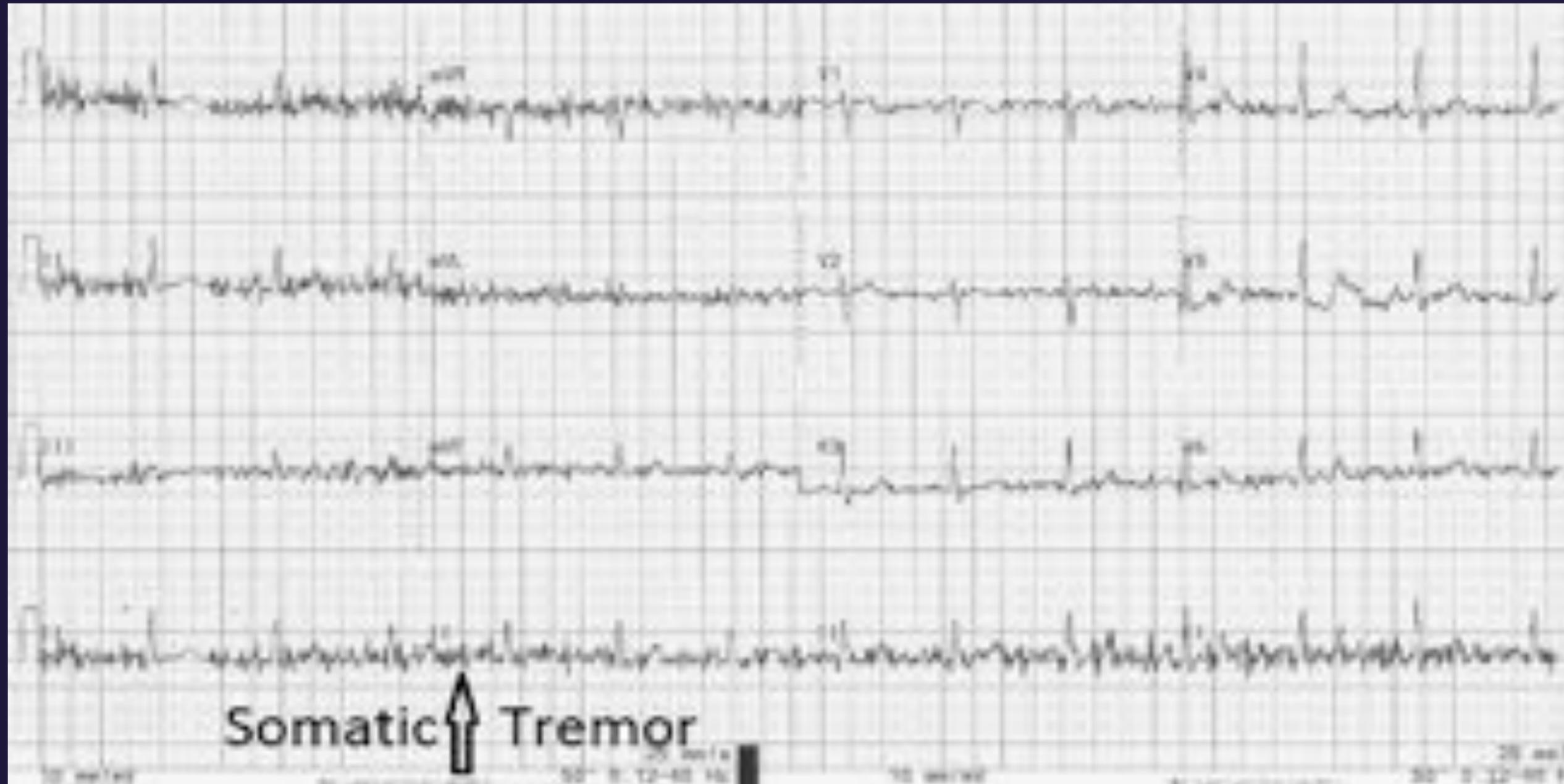
- Lose sensors--better skin prep, may need to abrade skin
- Have patient take deep breath, let half out and hold while acquiring ECG
- Cables moving
- Have patient lie still and stop talking
- Verify baseline filter is ON

# Muscle Artifact

- Choppy interference throughout the tracing
- Epidermal stretch-induced voltage changes (stretching the skin changes the potential) are the primary cause of motion artifacts, and such artifacts are not filtered.
- Caused by patient movement, shivering, muscle tensioning, talking, chewing gum, etc



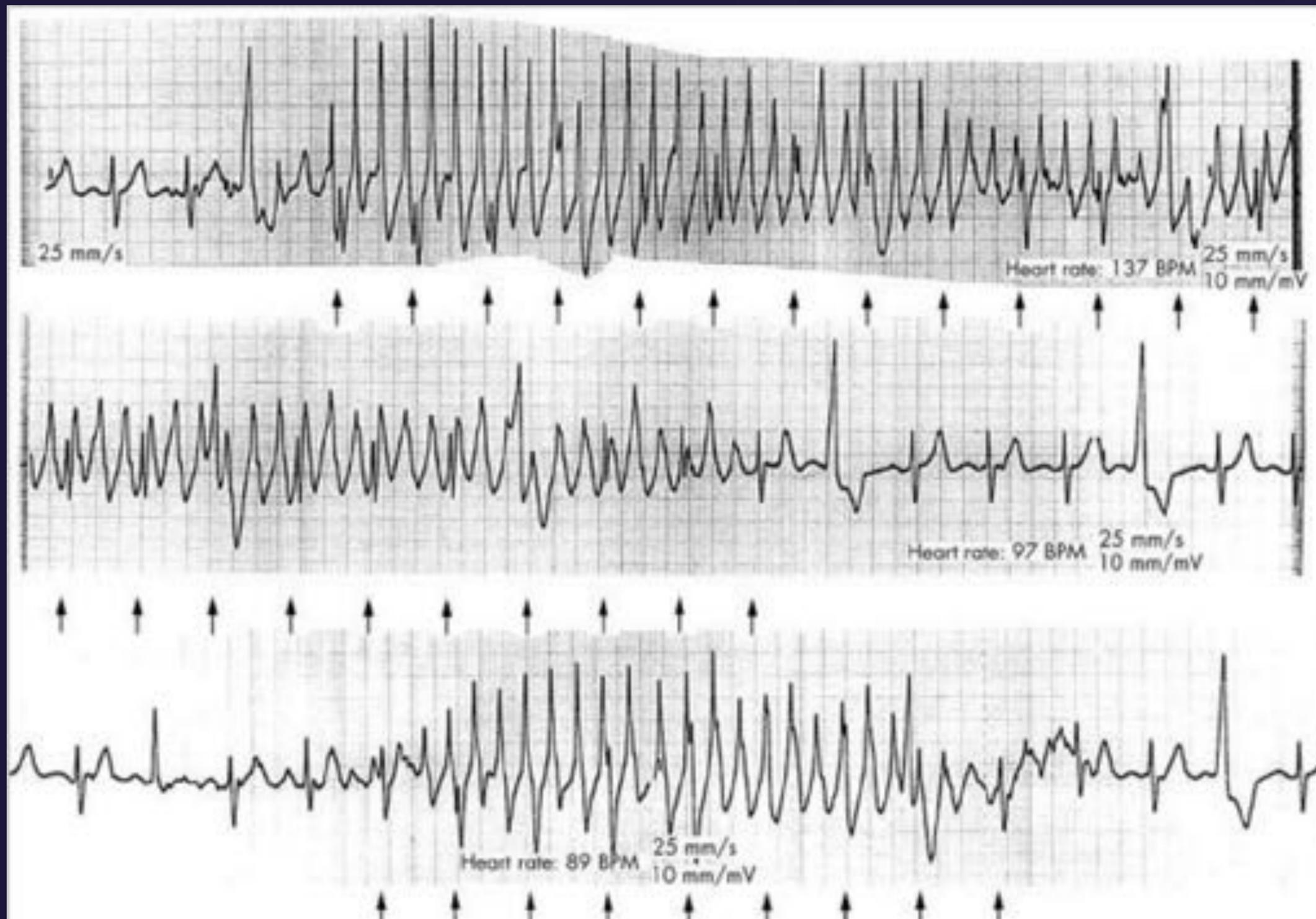
# Muscle Artifact



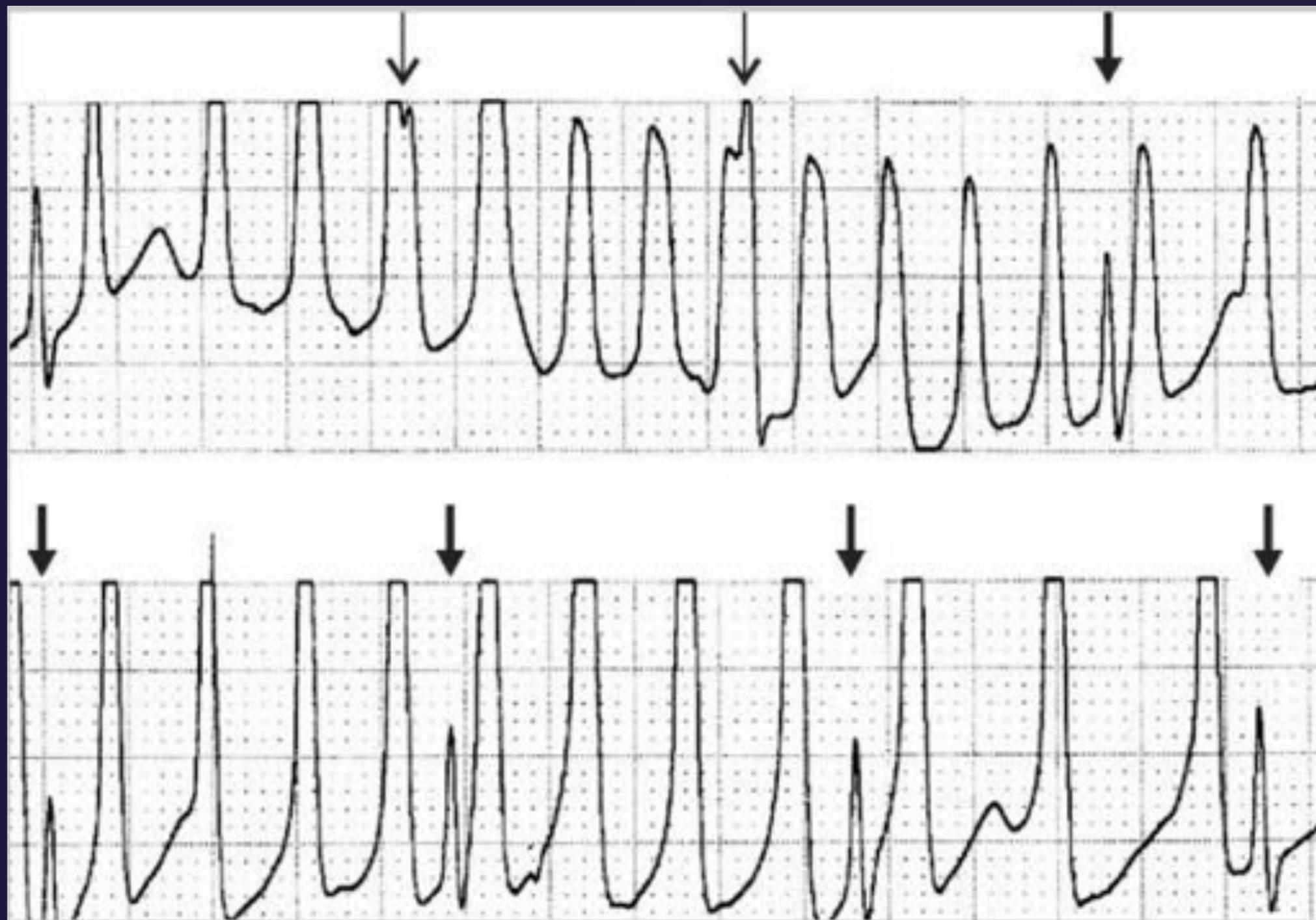
# Muscle Artifact

- Warm, relaxed patient (blanket)
- Arms at patient's side fully supported
- Pain control is necessary
- Move electrode to avoid culprit muscles

# Vtach Artifact



# Vtach Artifact

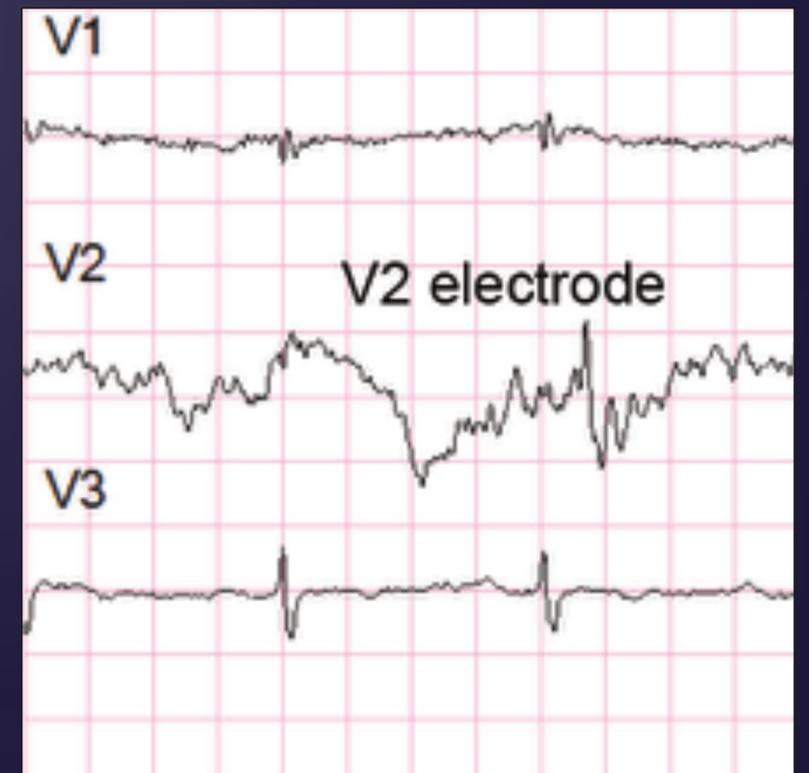
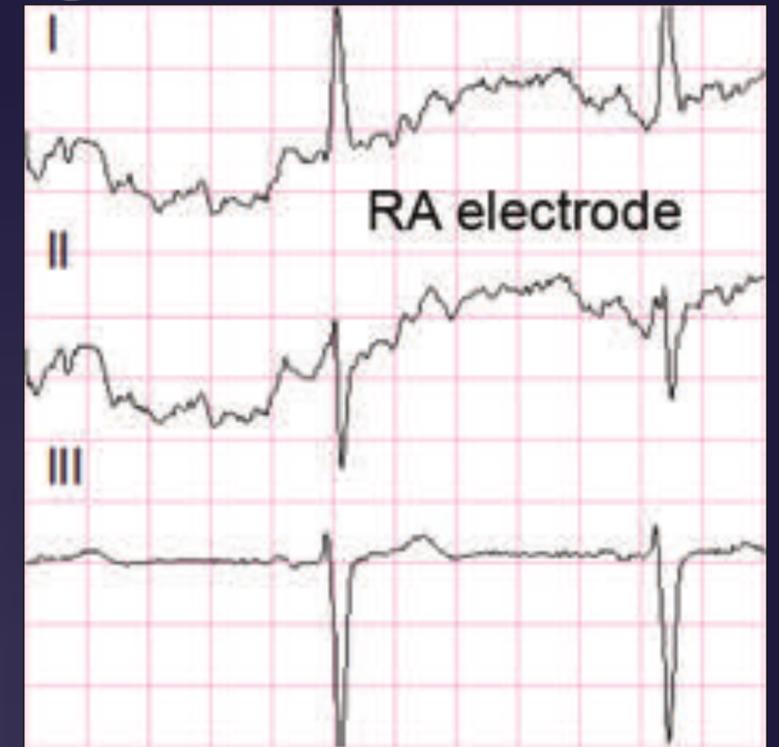


# Vtach Artifact

- Continued presence of normal QRS complexes at the cycle length of baseline rhythm within the apparent wide complexes (marked by arrows)
- An unstable baseline on the electrogram before the tachycardia events. This resulted in the recognition that the wide complexes were electrocardiographic artifacts.
- Absence of haemodynamic deterioration

# Culprit Electrode

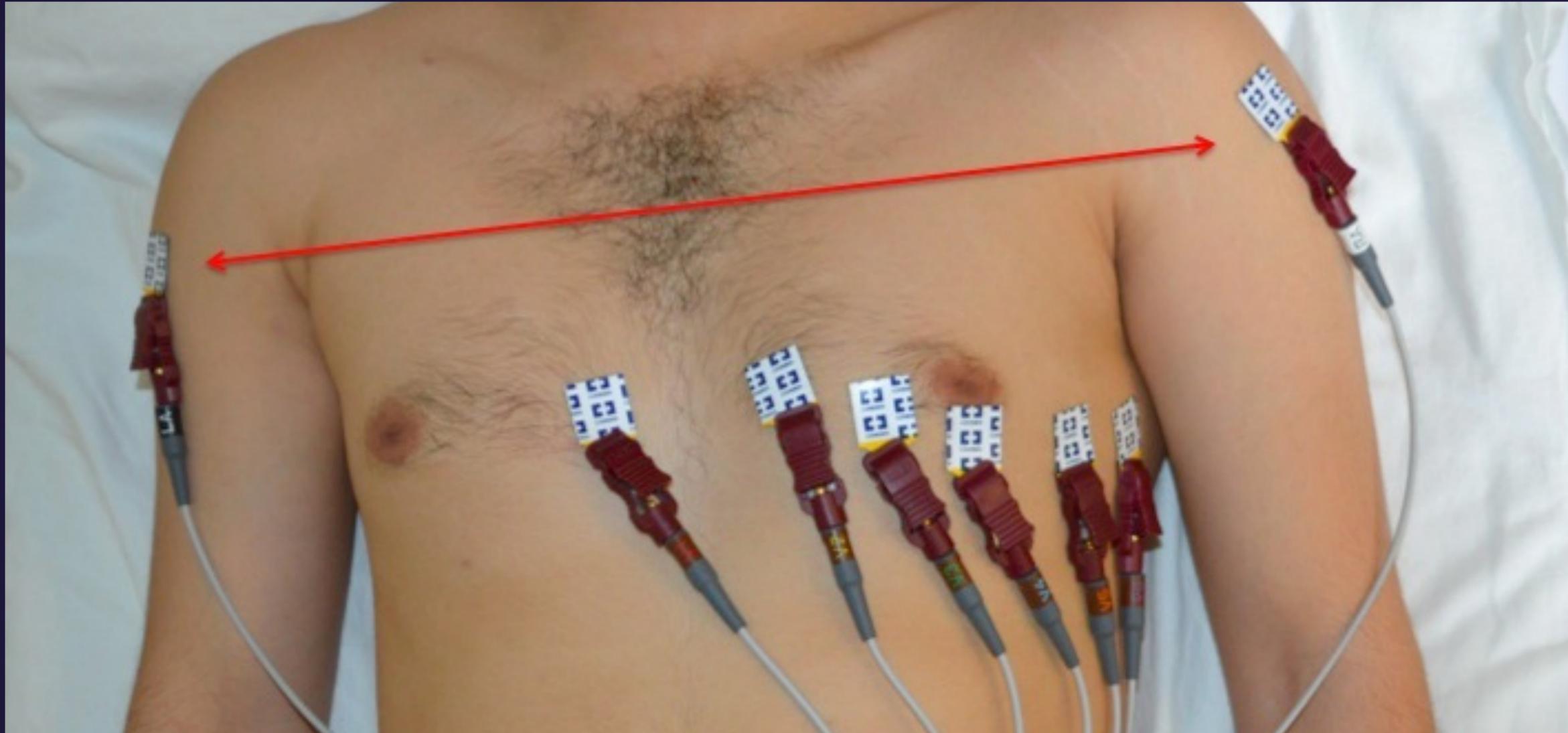
- Artifact in leads I and II but not III, the RA electrode is the source
- Artifact in I and III but not II, the LA electrode is the source
- Artifact in II and III but not I, the LL electrode is the source
- Artifact is unique to one V lead, its V electrode is the source



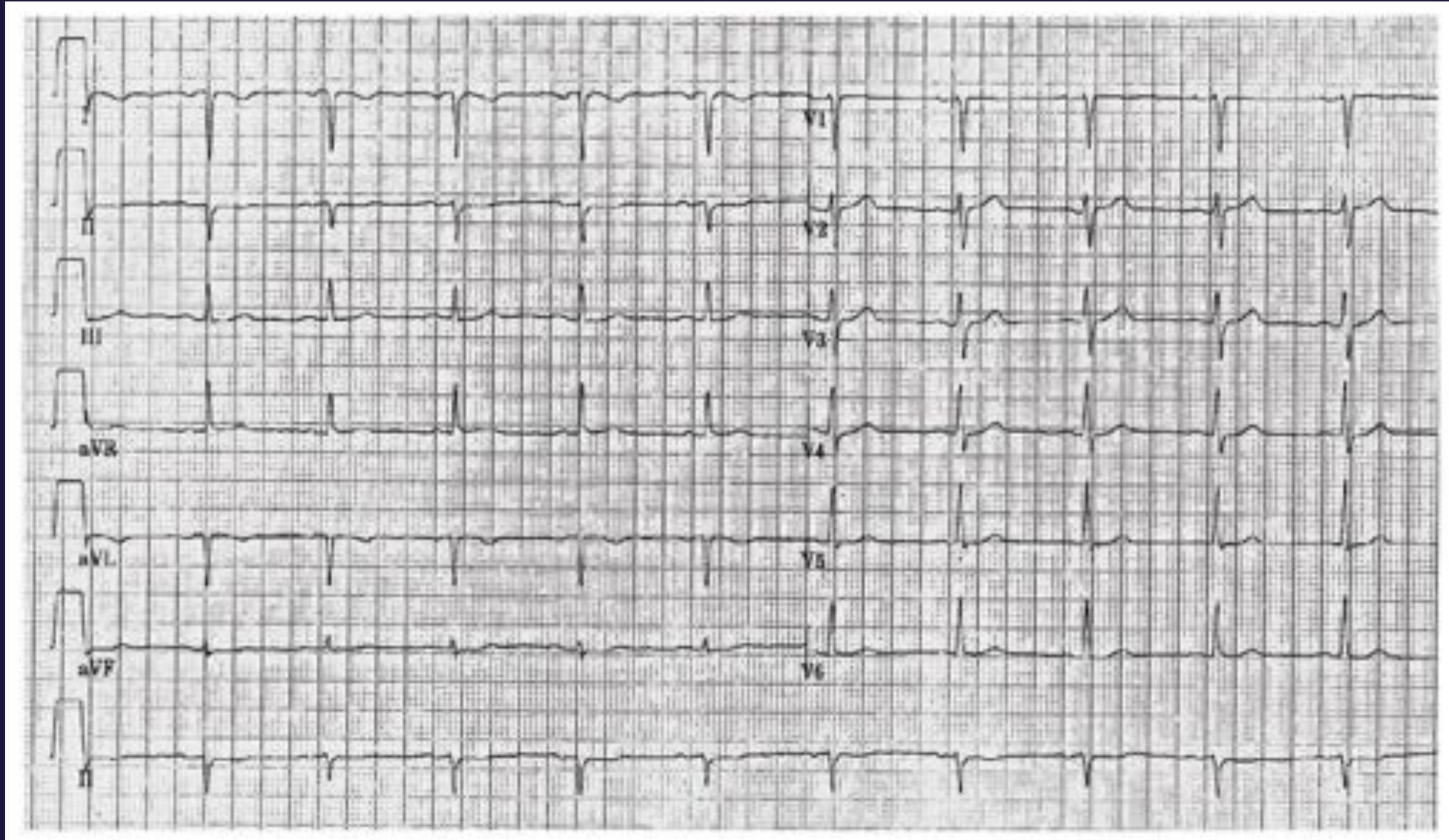
# Lead Reversal

- Lead switches are a common mistake when ECGs are made and can lead to wrong diagnoses.
- Left-right arm reversals lead to a negative complex and negative p wave in lead I
- Arm-foot switches lead to very small signal in leads II or III
- Chest lead reversals lead to inappropriate R wave progression (increase-decrease-increase)
- Any right axis or small signal in an extremity lead should be reason enough to check lead positioning

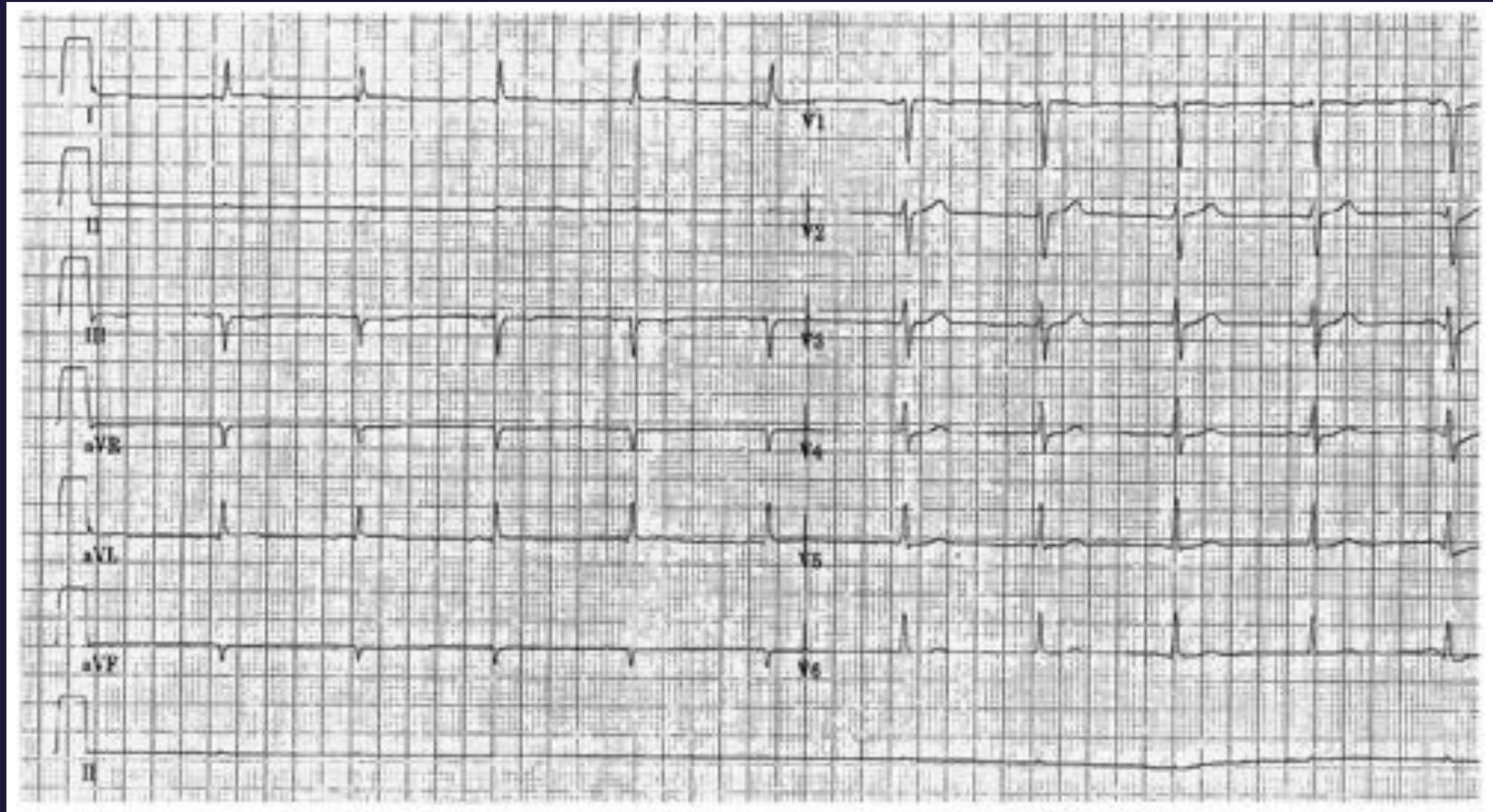
# Left-Right Lead Reversal



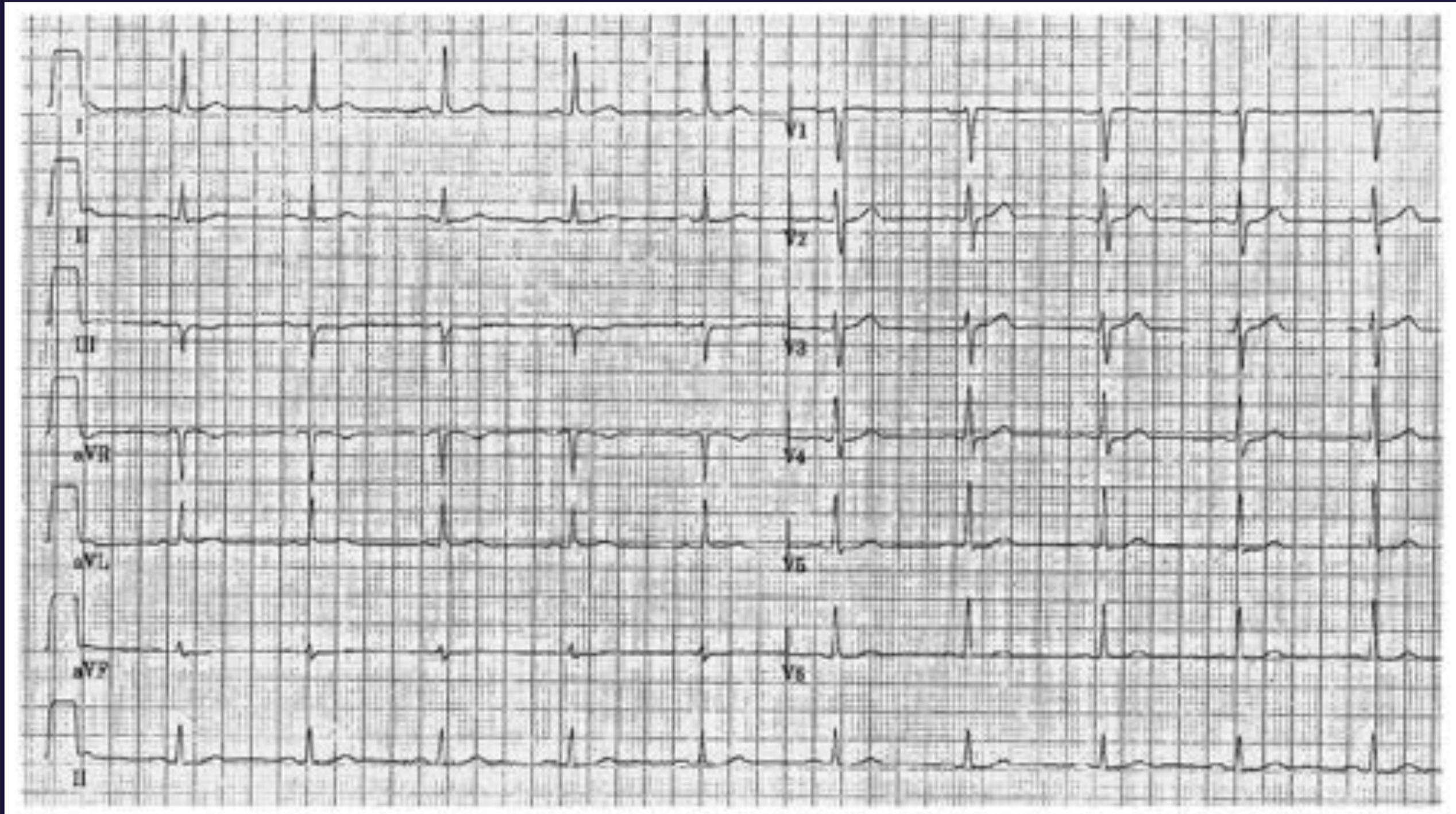
# Left-Right Lead Reversal



# Right Arm - Right Leg Reversal



# Chest Lead Reversal

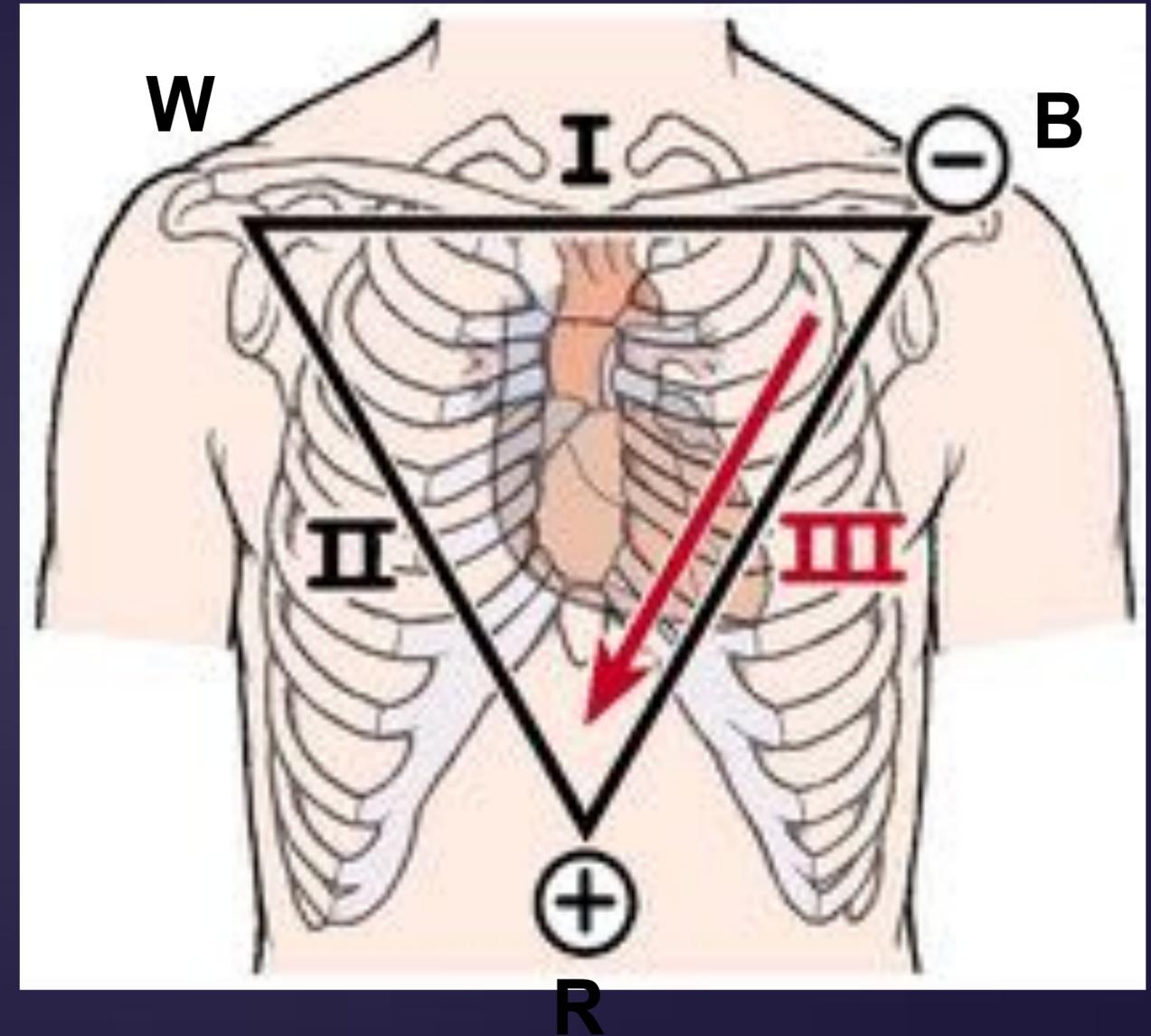


# Monitoring

- Different purpose than 12-lead
- Looking for rhythm changes
- Choose the lead that gives the best picture of the p waves and QRS
- Often lead II, lead I or a chest lead

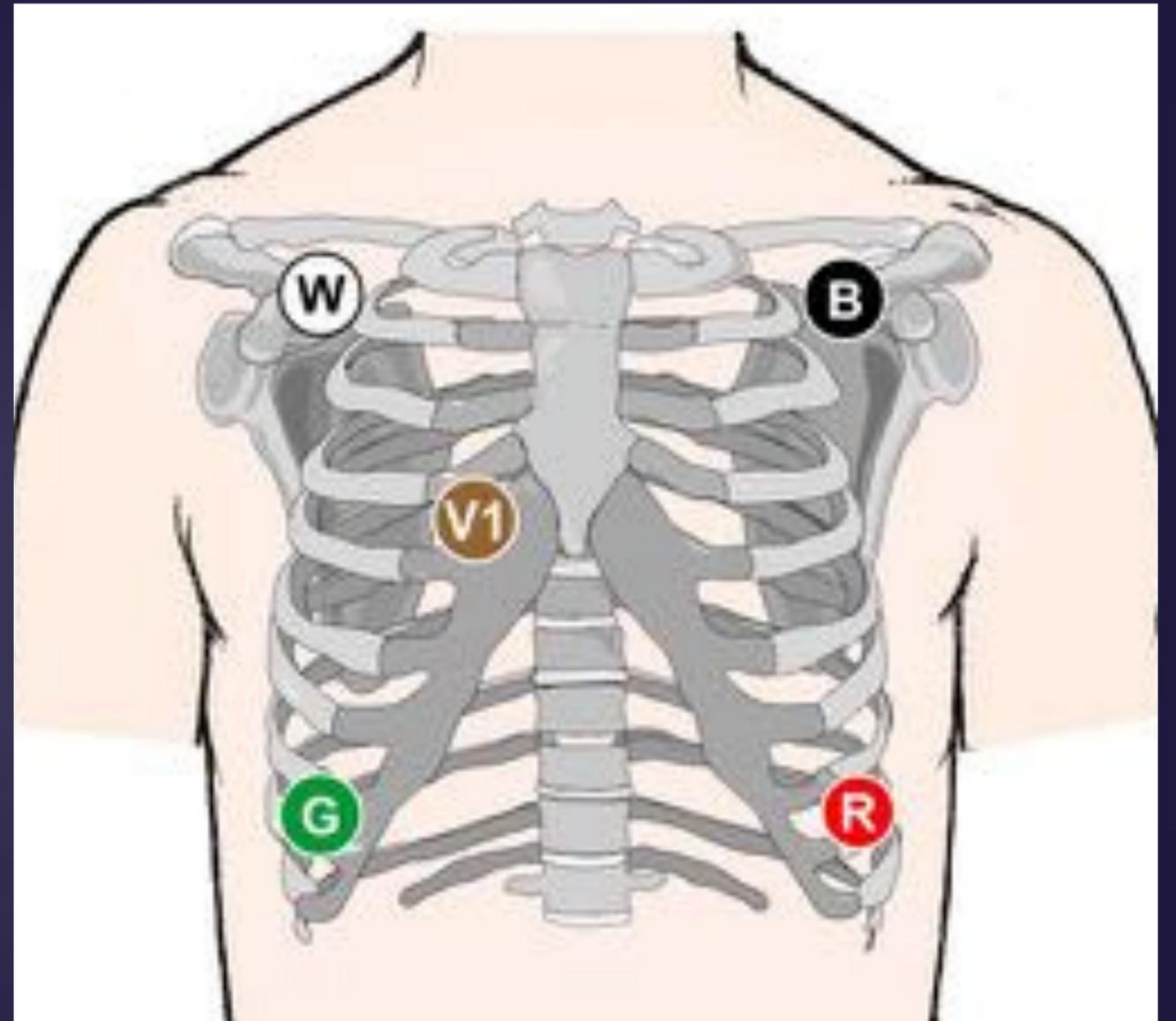
# 3-Lead Telemetry

- Lead II great for looking at apex of heart



# 5-lead Telemetry

- Lead II only 33% accurate in identifying SVT
- 12-lead can 90%
- V1 best single lead



# Monitoring

- Monitoring leads placed on torso
- Wires to wrist and ankle tangle up patient
- Close in the voltages will be higher, but no difference in time intervals
- ST segments are not comparable to the 12-lead, but can be trended

# Analyzing ECG

- Fast / Slow / Normal
- QRS wide or narrow
- Regular or Irregular
- ST Segments
- Symptoms & Vital signs

# Fast / Normal / Slow

- Classify the rate of the QRS complexes as bradycardic or tachycardic (or normal)
- Presence there p waves, and do they precede the QRS

# Regular / Irregular

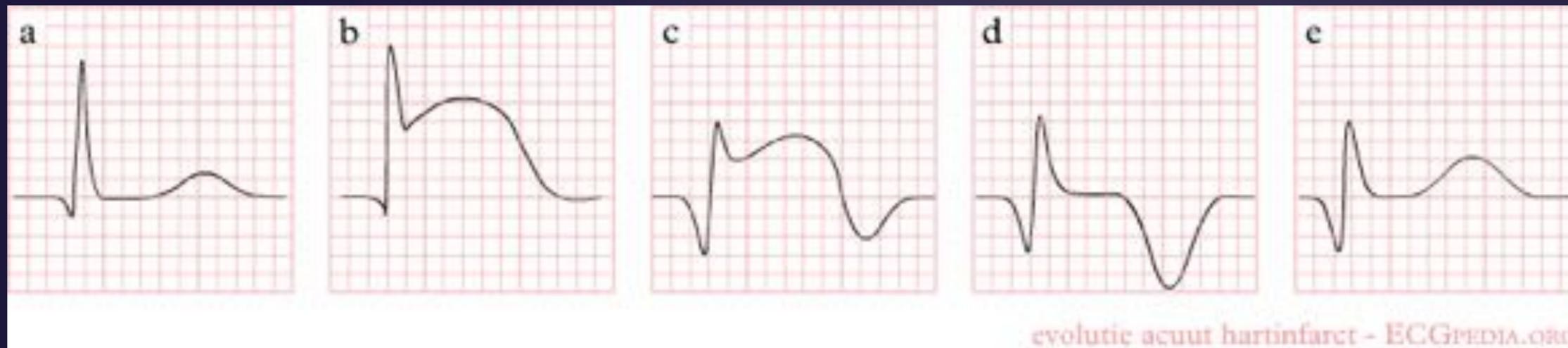
- Is the rhythm regular or irregular
- Is there a pattern to the p waves and QRS
  - Regularly irregular or irregularly irregular
- Eyeball, calipers, fold over

# Wide / Narrow QRS

- 120 ms (3 small boxes)
- Narrow complex are traveling down normal AV node route
- Wide complexes indicate pulses are taking abnormal path

# ST Segments / T waves

- Ischemia -- inadequate perfusion to meet metabolic needs
- Injury -- cell death marked by troponin elevation
- Infarction -- Cell death due to prolonged ischemia
- Dynamic process



# ST Segments / T Waves

- 1 mm ST Elevation in 2 contiguous leads
  - 1.5mm for V2/V3 for women
  - 2mm for V2 / V3 in men >40
  - 2.5mm for V2 / V3 in men < 40
- Reciprocal changes / Dynamic T waves
- ST Depression

# Symptoms & Vital Signs

- What is the patient telling me?
- Is there -- hypotension, chest pain, SOB, hypoxia, abdominal pain
- How can I put the ECG together with this patient?

# Putting It All Together

- Bradycardia — Sinus bradycardia, junctional escape, ventricular escape
- Irregularly irregular rhythm — atrial fibrillation, multifocal atrial tachycardia, wandering atrial tachycardia
- Wide QRS — VTach, ventricular rhythm, RBBB, LBBB, drug effects, Hyperkalemia

