Temporary Pacemakers

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Topics to be covered

- Indications
- Pacemaker nomenclature
- Insertion Technique
- Complications
- Orientation to "the box" (Pacemaker)
- Troubleshooting

- Questions?

General indications for a temporary pacemaker

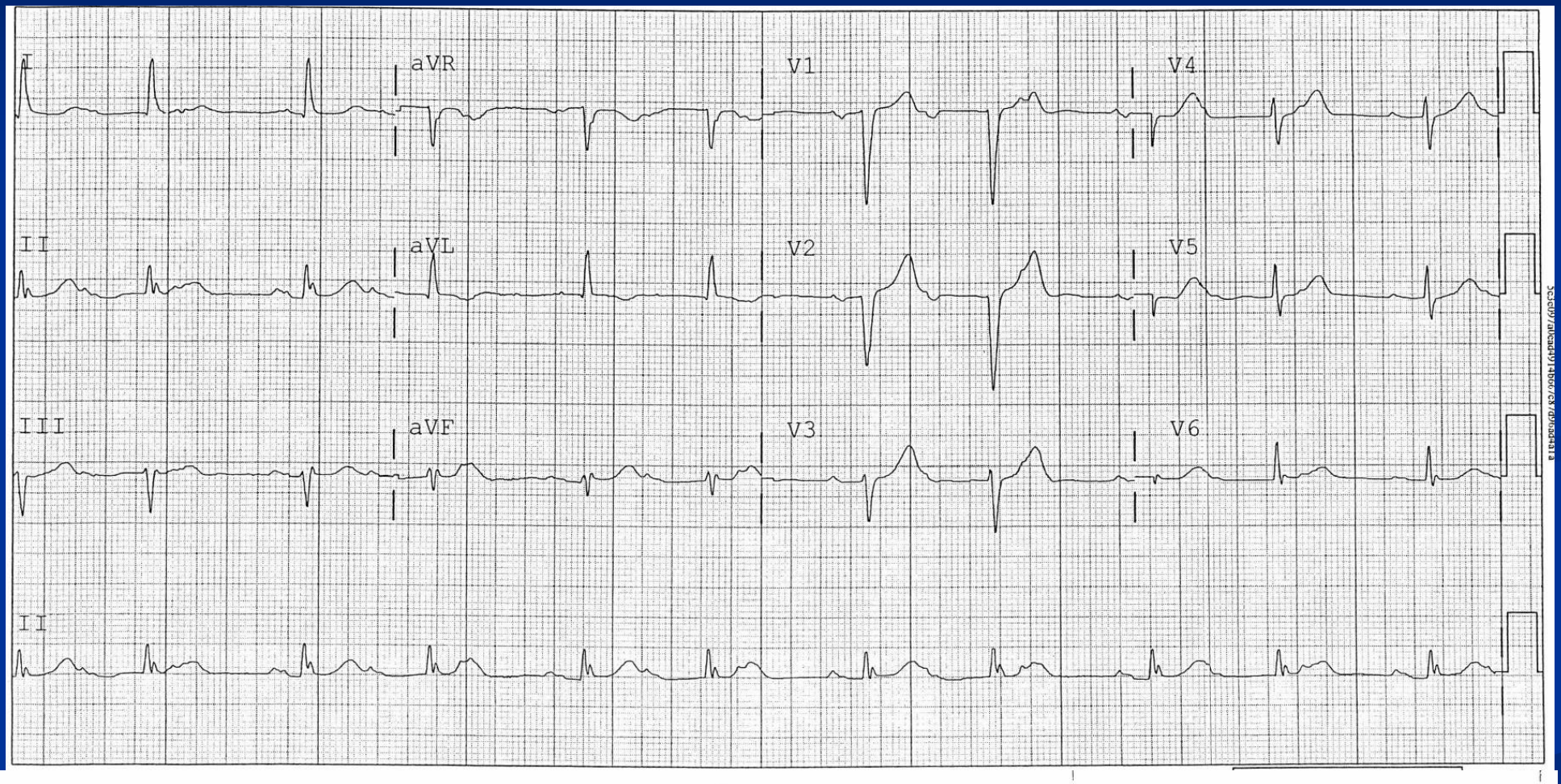
- Heart rate is slow, causing hemodynamic compromise
- Sick sinus syndrome
  - Sinus bradycardia or atrial fibrillation with slow heart rate response (generally <40 bpm)
- Heart block
  - 3rd degree
  - 2nd degree type 2 (Mobitz)
- Malignant Tachyarrhythmia caused by bradycardia
  - Torsades de Pointes

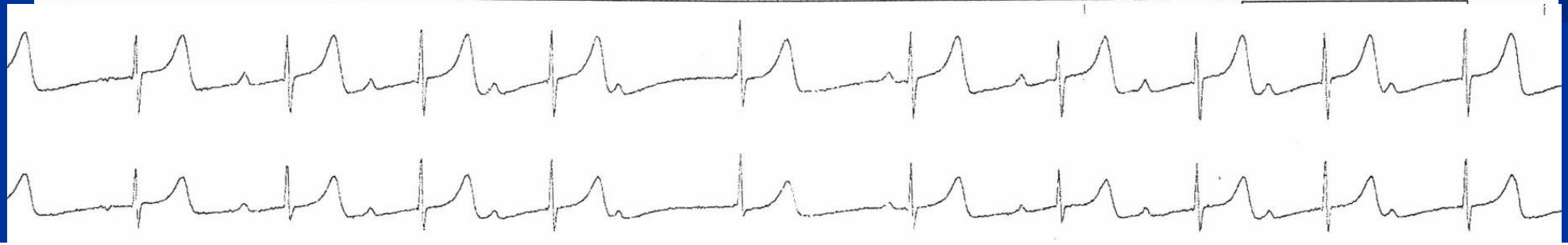
Clinical settings for temporary pacemaker

- Syncope
- Myocardial infarction
  - Especially inferior
- Shock due to bradycardia
- Myocarditis
- Lyme disease

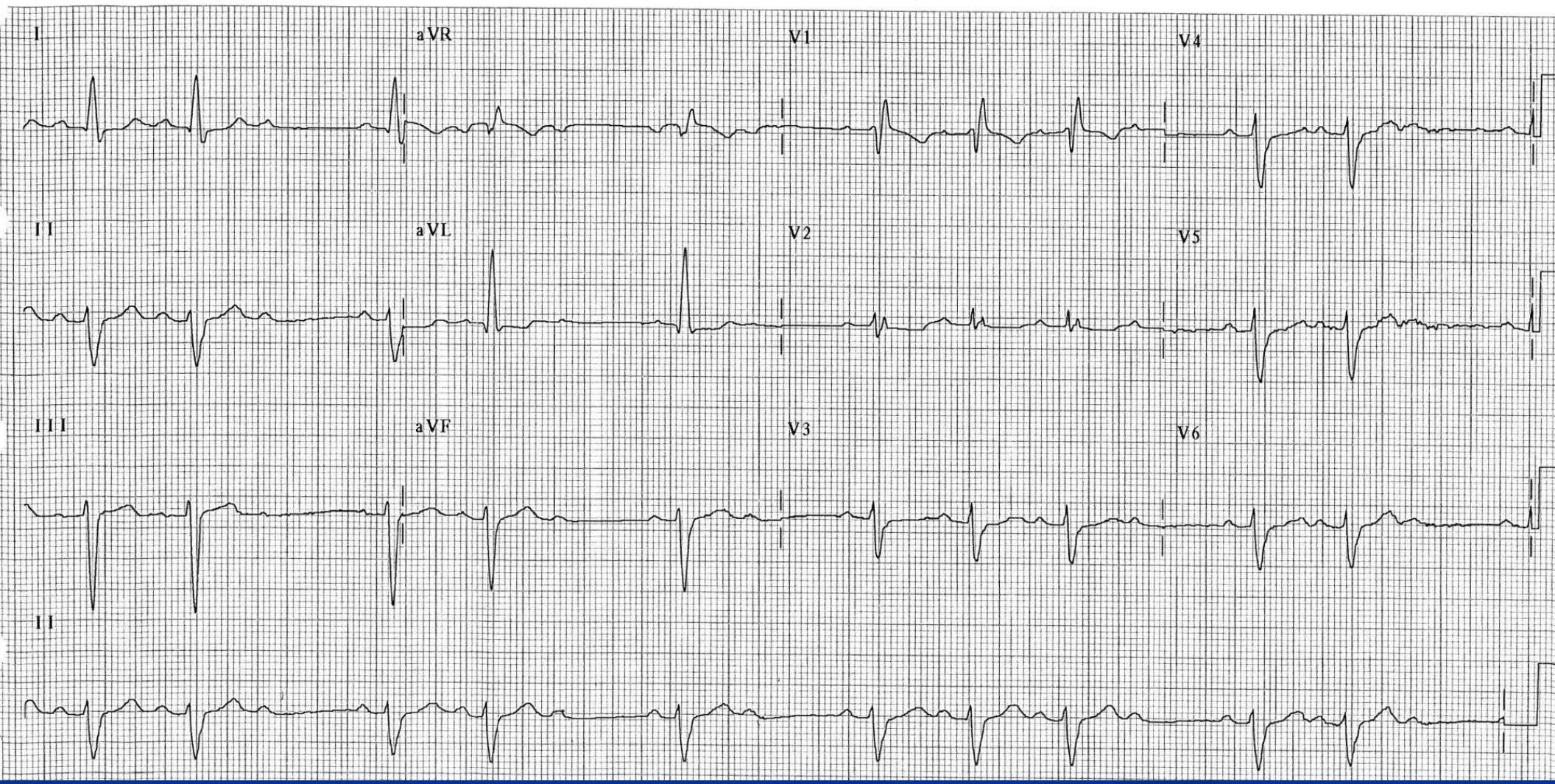
2nd Degree AV block type 1

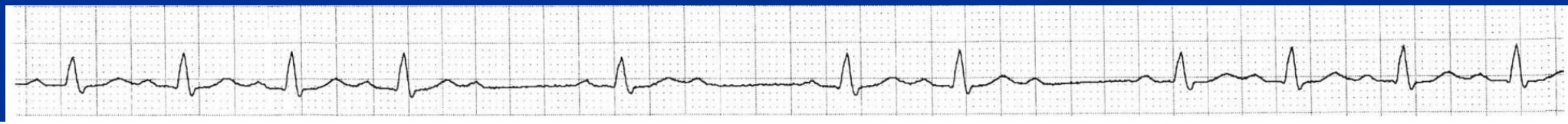
Wenkebach – not a reason for pacemaker



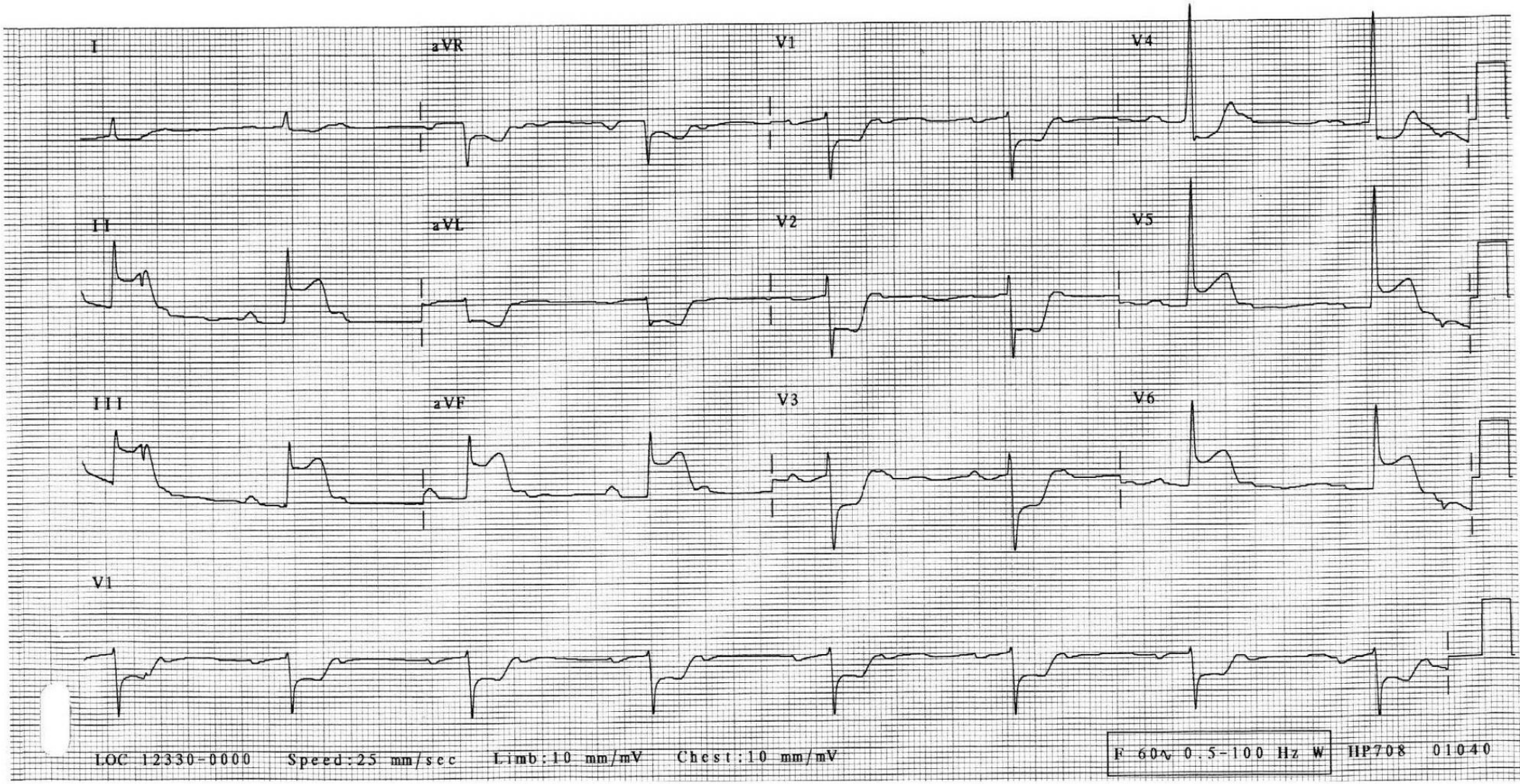


2nd Degree AV block type 2 (Mobitz)

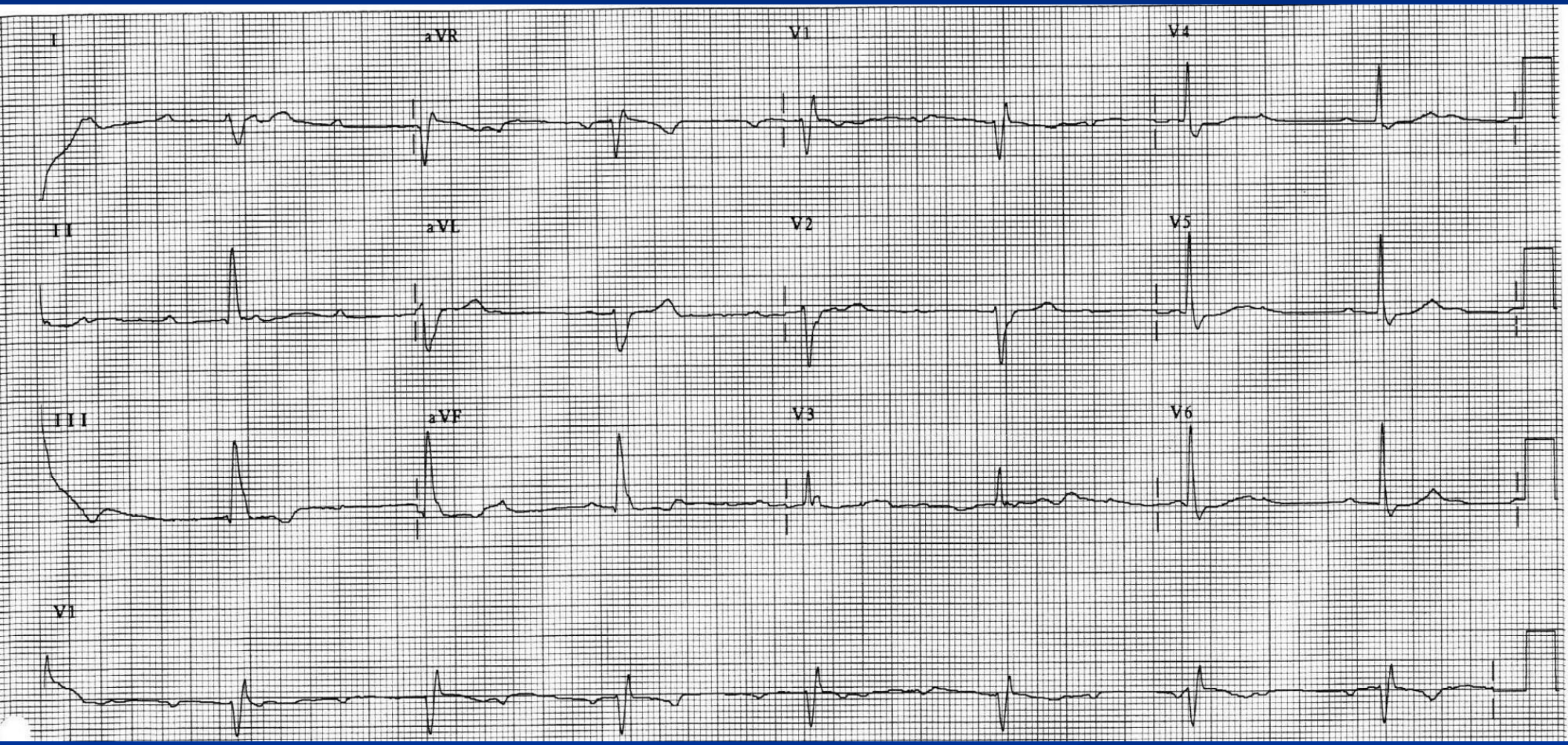




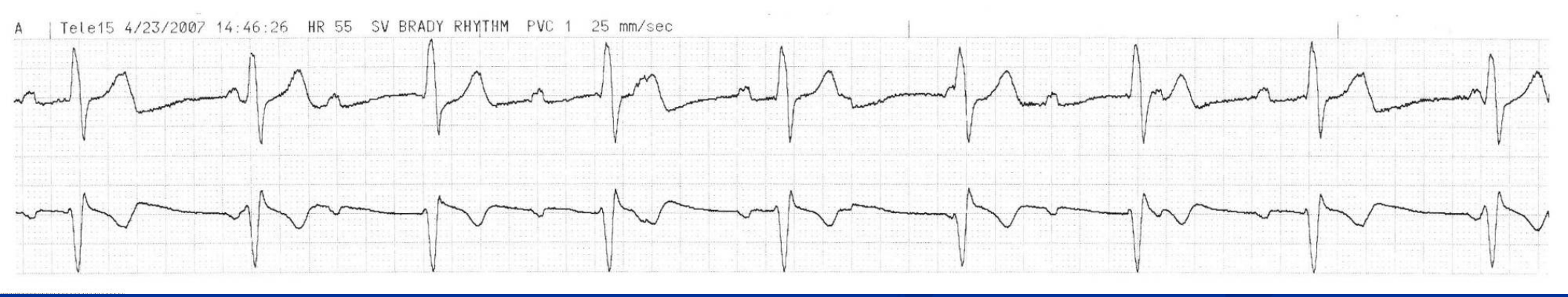
Inferior/Lateral/Posterior Infarct with 2:1 block



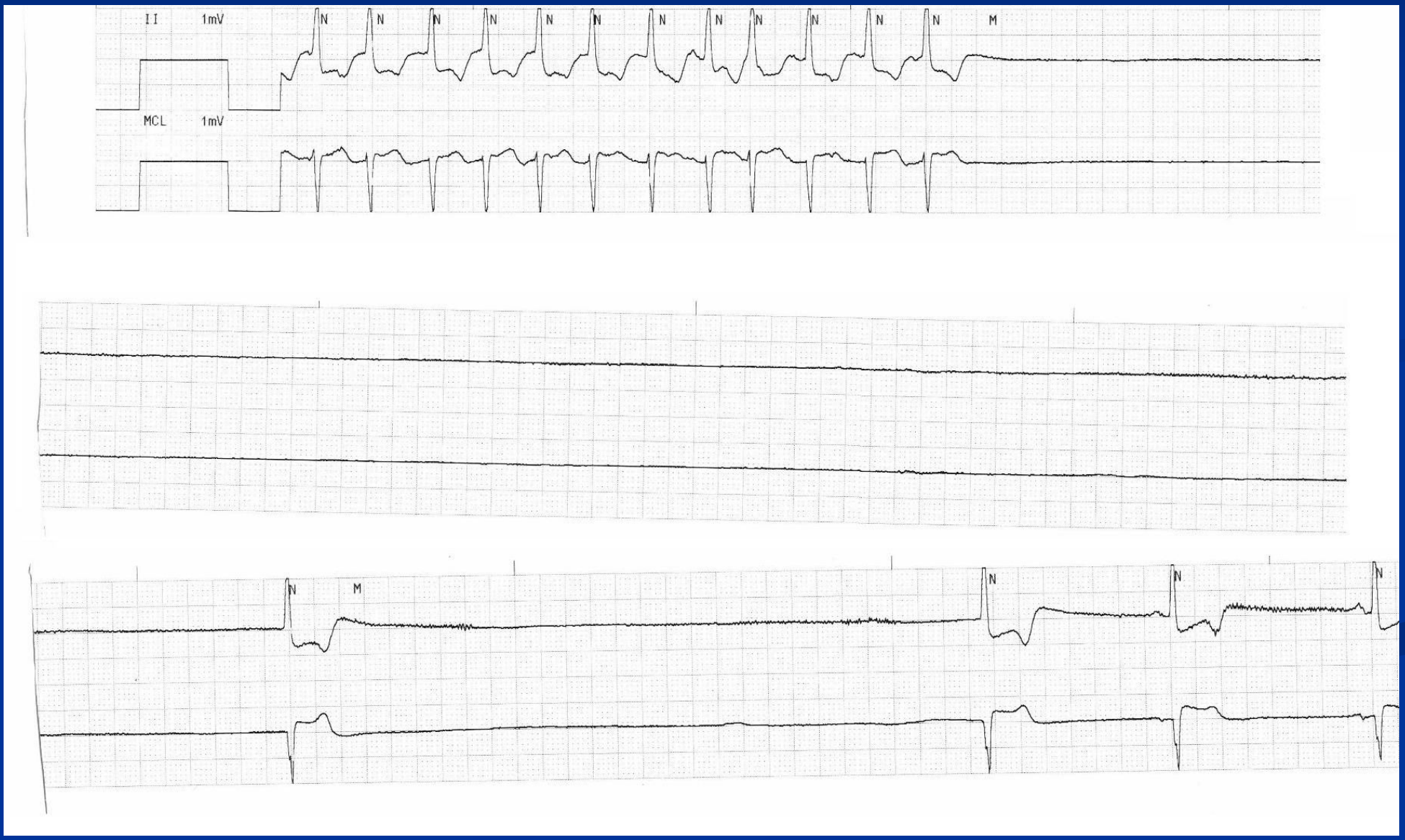
3rd degree heart block



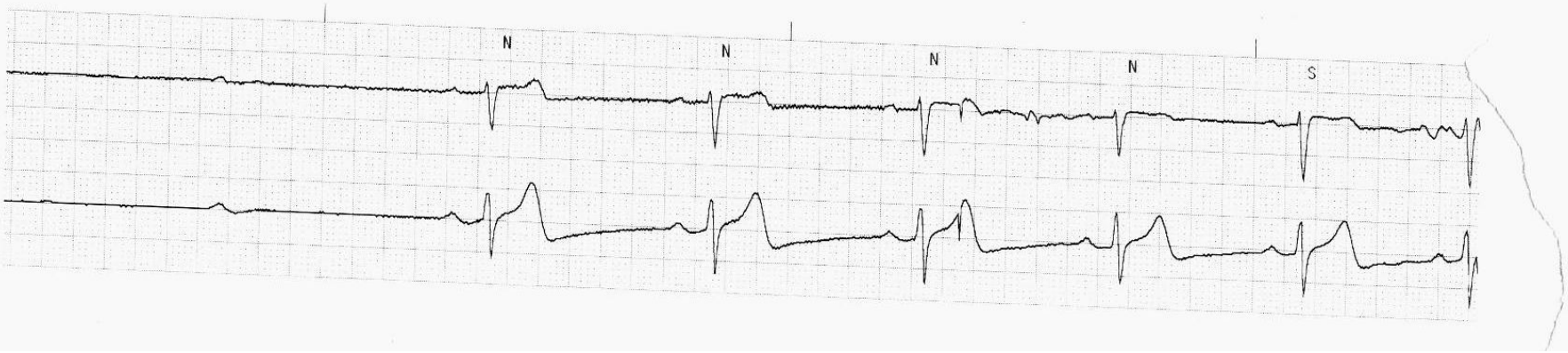
Another 3rd degree heart block



Atrial fibrillation → Asystole



NSR → 20 second asystole

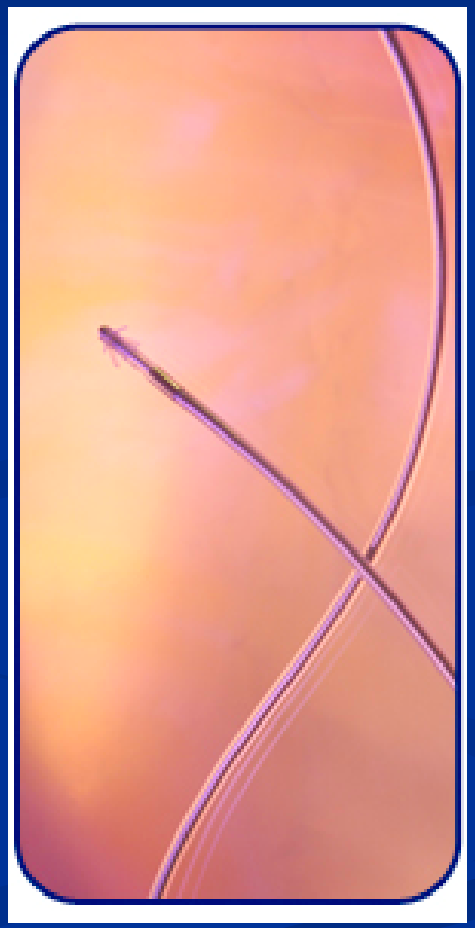


Pacemaker Nomenclature

- Common Modes
  - VVI – Single chamber (ventricle)
  - DDD – Dual chamber
  - AAI (uncommon) – Single chamber (atrium)
- 1st Letter is chamber PACED
- 2nd Letter is chamber SENSED
- 3rd Letter is response
  - I = Inhibit
  - T = Triggered (Unusual)
  - D = Dual (Inhibit or Pace)
- 4th Letter – R = Rate responsive (permanent pacers)

Components of a pacemaker system

- Lead
  - Wire connects to heart
    - Percutaneous
      - Ventricular wire sits in RV apex
    - Epicardial (post surgery)



http://www.oscor.com/images/lead%20pics/RU-STR-Polaris%20lead2%20copy.jpg

The Can

AKA "Pulse Generator," "Battery"

Temporary

Single chamber

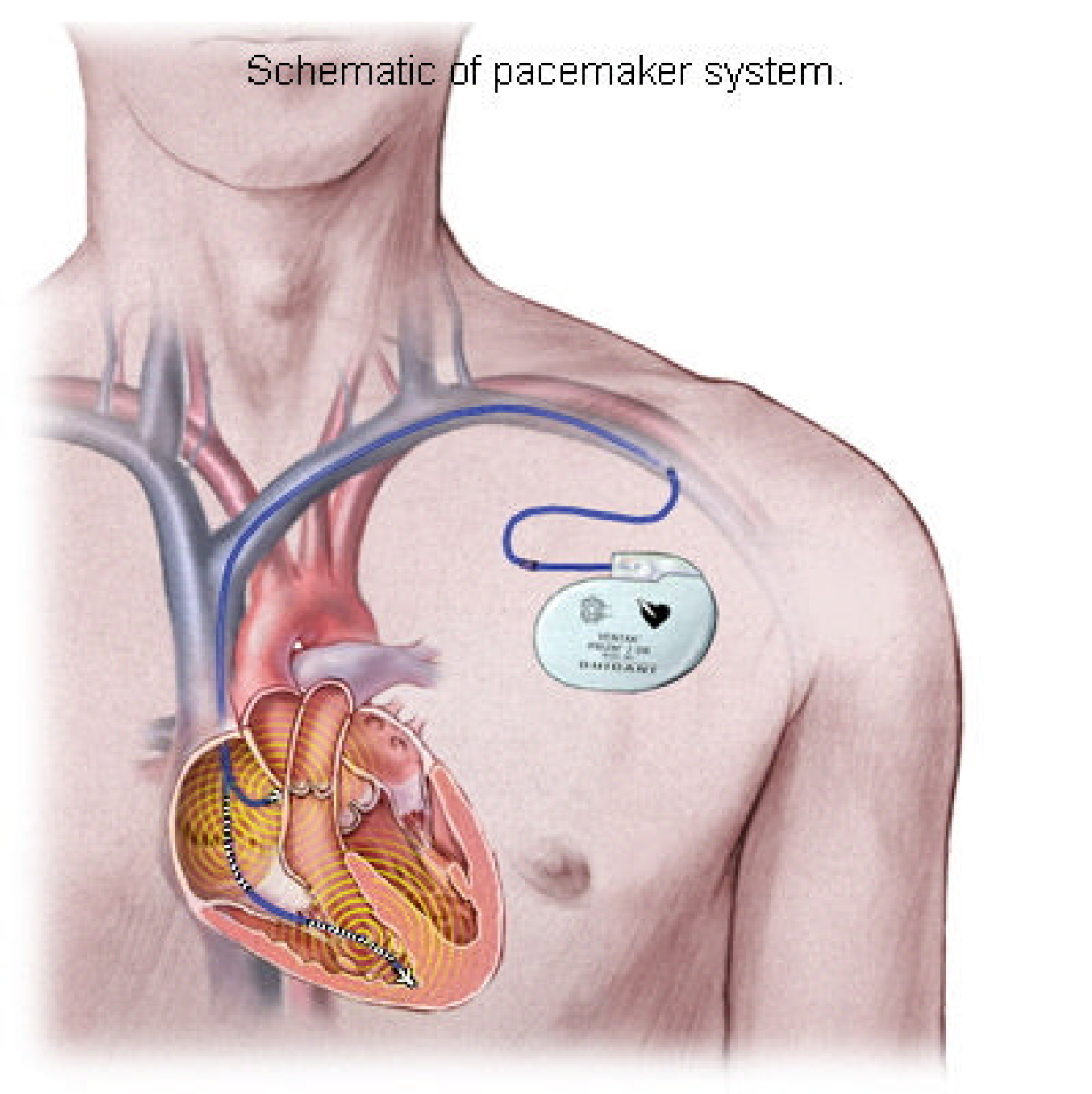
http://www.staff.vu.edu.au/CriticalCare/Critical%20Care/Images%20_l1/spacer.gif

Dual chamber

http://intensivecare.hsnet.nsw.gov.au/five/images/generator.jpg

Permanent single chamber

http://upload.wikimedia.org/wikipedia/commons/thumb/b/b1/Pacemaker_GuidantMeridianSR.jpg/549px-Pacemaker_GuidantMeridianSR.jpg

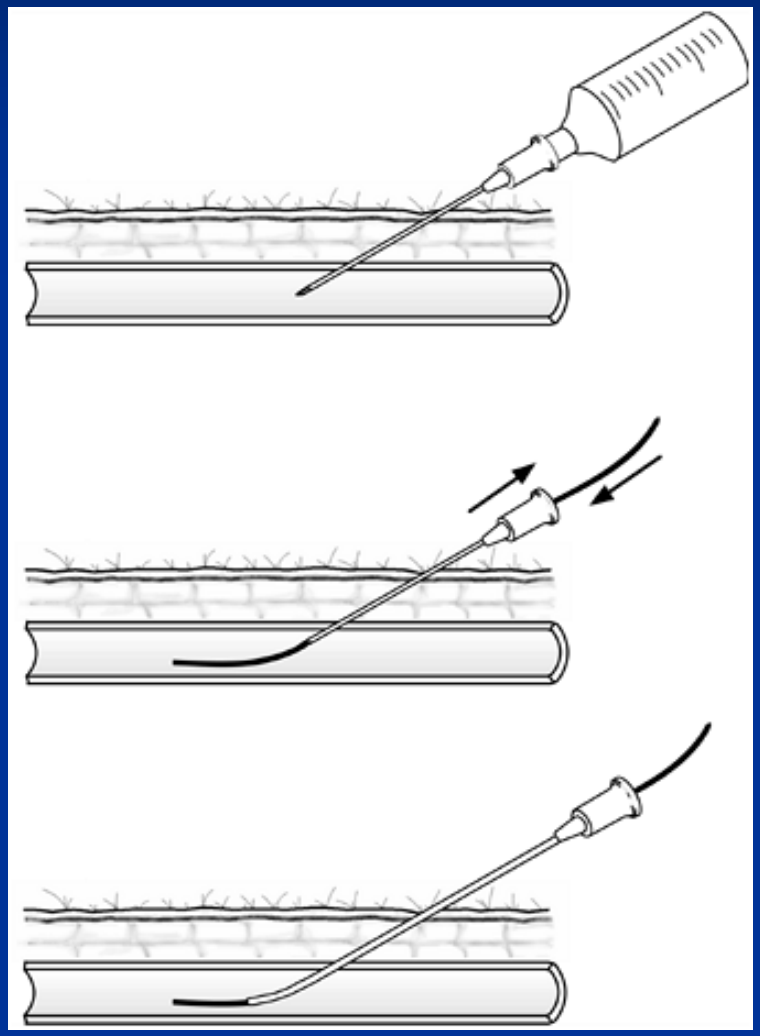


http://www.hgcardio.com/HRhythm/Treatments/a_pacemaker_schematic.jpg

Sites of insertion for a temporary pacemaker

- Right internal jugular
- Left subclavian vein
- Right subclavian vein
- Either femoral vein (Fluoroscopy required)
- Left IJ is possible but very difficult

Seldinger technique for percutaneous vascular access



ICU Book (Marino)

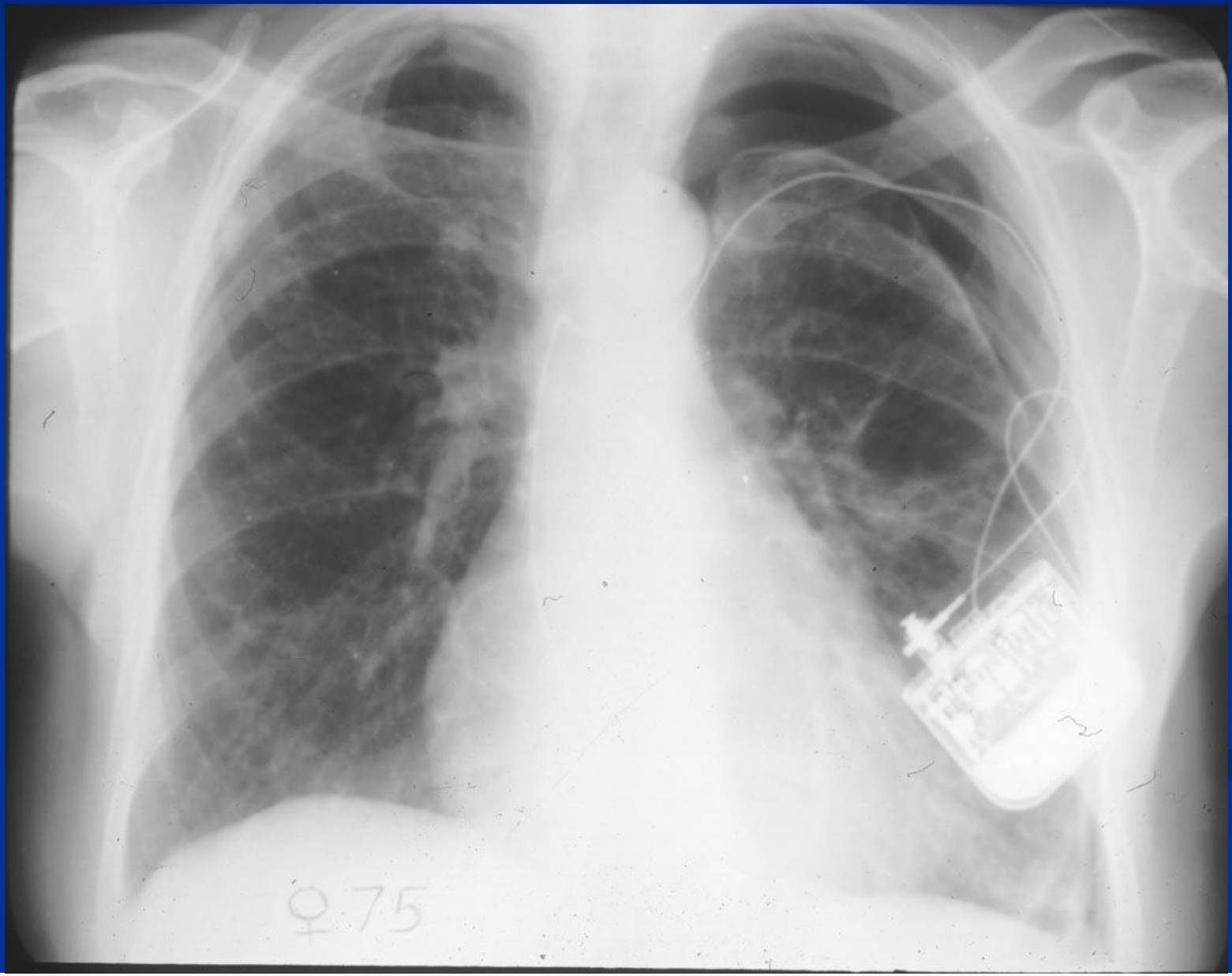
General steps

- Trendelenberg position or leg elevation can facilitate access to IJ and subclavian veins
- Sterile Field
- Anesthetize skin with lidocaine
- Access vein with Cook needle
- Insert guidewire
- Remove needle
- Consider making a skin nick with scalpel
- Insert 6-8F introducer sheath with dilator over guidewire
- Remove dilator and guidewire
- Flush sheath using side port
- Advance temporary pacemaker to right ventricle

Complications of temporary pacemaker insertion

- Blood loss/hematoma
- Infection
- Arrhythmia (especially during insertion)
  - PVC's are common
  - Heart block
    - Especially in patients with underlying LBBB
  - Bundle branch block
- Pneumothorax (about 1+% when subclavian access used)
- Cardiac perforation → Tamponade

Pneumothorax of Left Lung



http://myweb.lsbu.ac.uk/dirt/museum/margaret/66--732-1160120.jpg

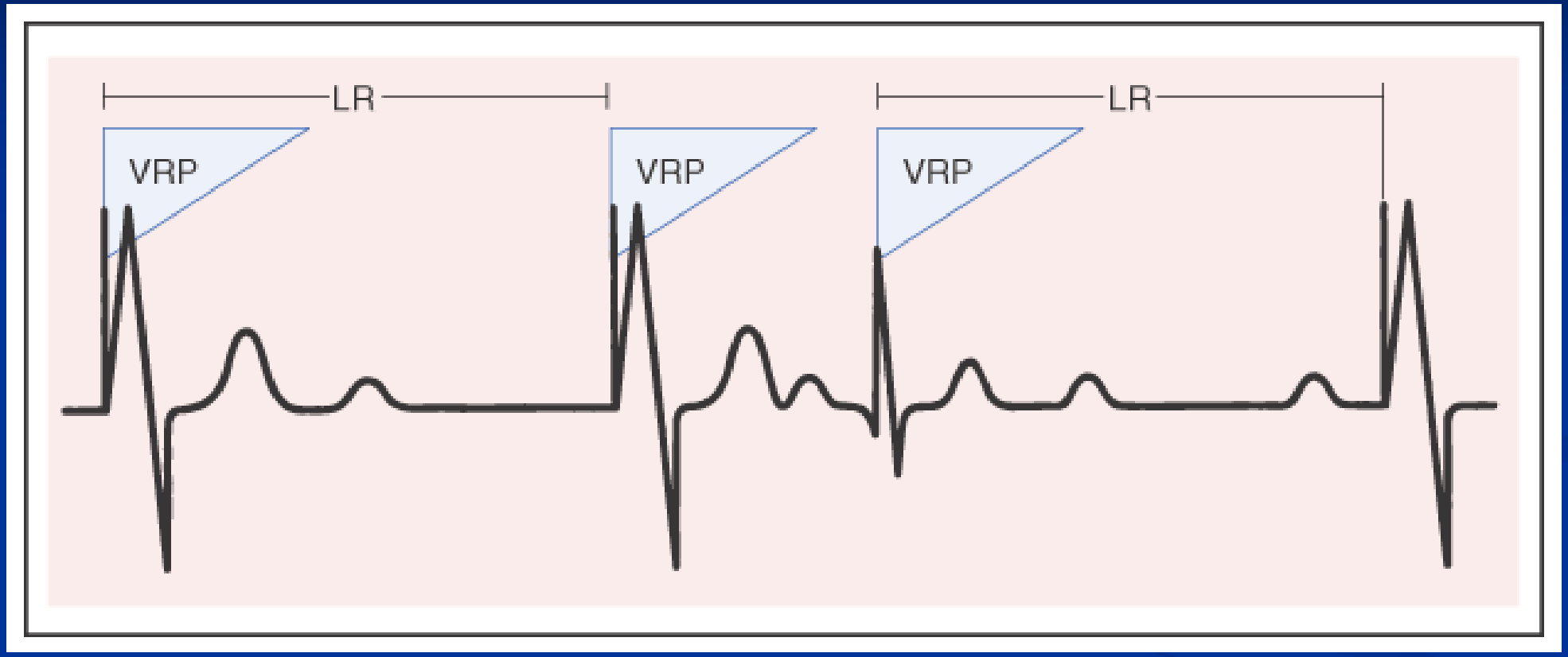
Functions of a pacemaker

- Sensing
  - The device ‘sees’ a native heart beat
- Pacing
  - The device delivers a shock to stimulate a heart beat

VVI Explained

- A VVI pacemaker
  - Paces the ventricle
  - Senses the ventricle
  - In response to a sensed event it INHIBITS the pacing response
    - So if it doesn't SENSE a native heart beat in a specified period, it will deliver a pace.

Timing cycles



Braunwald, 7th ed.

VVI pacemaker
LR = lower rate limit
VRP = ventricular refractory period
Note that a sensed QRS starts the VRP and resets the LR

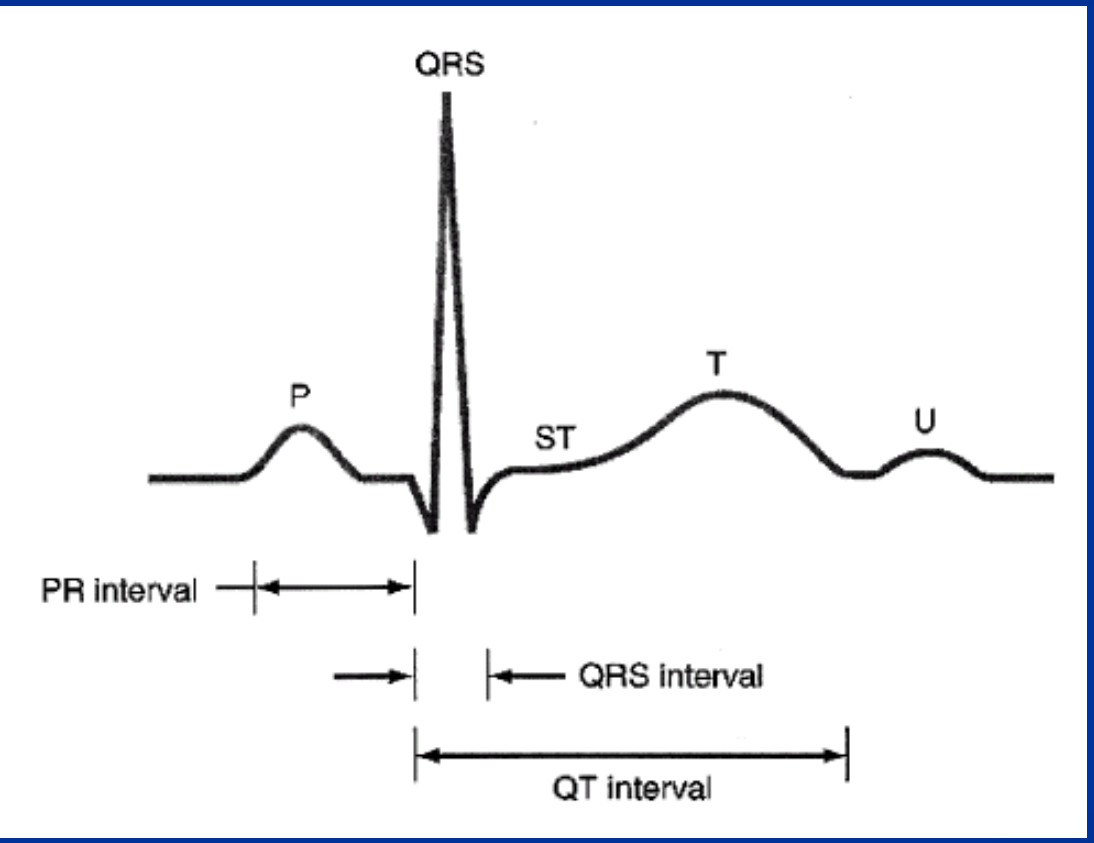
The dials on the Temporary pacemaker

- Rate
  - Determines the lower rate limit of the device
  - Heart rate should not go lower than the set rate
- Output
  - In milliamps, the amount of 'juice' the device outputs with each pacer spike

Sensitivity

- Sensitivity → asynchronous
  - In millivolts, the amount of energy that has to be detected in order for the device to 'sense' a beat
  - Higher millivolts = less sensitive
    - More likely for the pacemaker to pace at the lower rate regardless of what the heart does on its own
  - Lower millivolts = more sensitive
    - More likely to pick up noise, and 'sense' a ventricular beat even though nothing actually happened

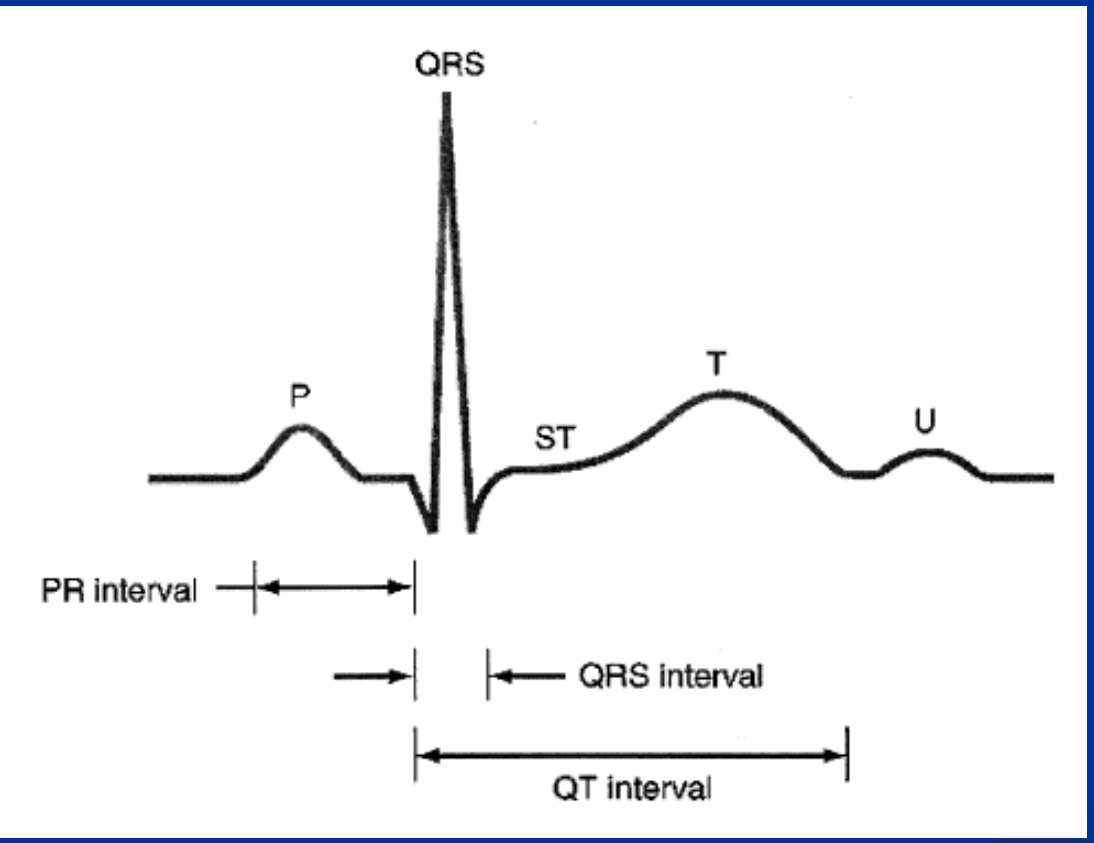
Sensitivity

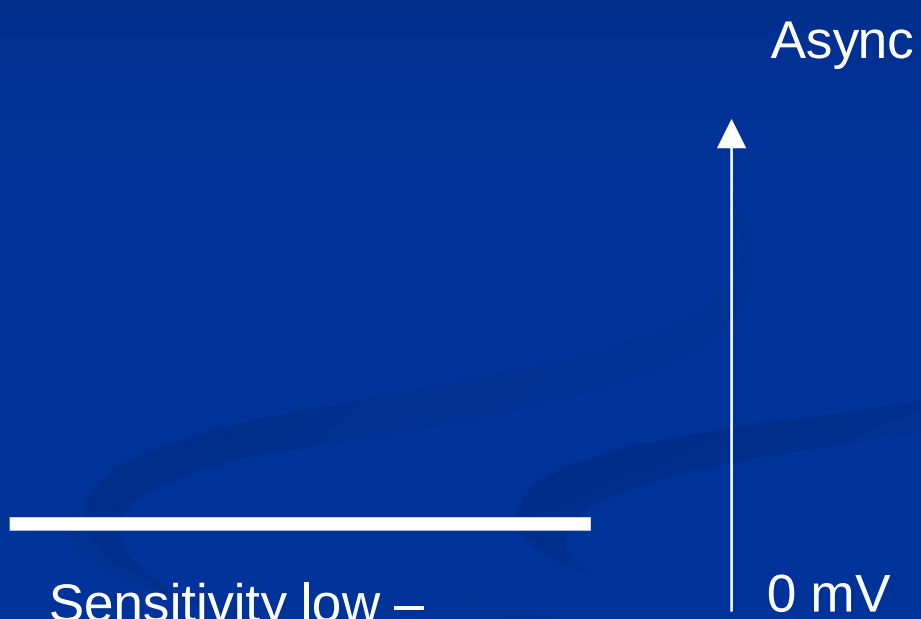


Sensitivity low – Everything (QRS, T, U) can be sensed by the pacemaker as a QRS

http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif

Sensitivity

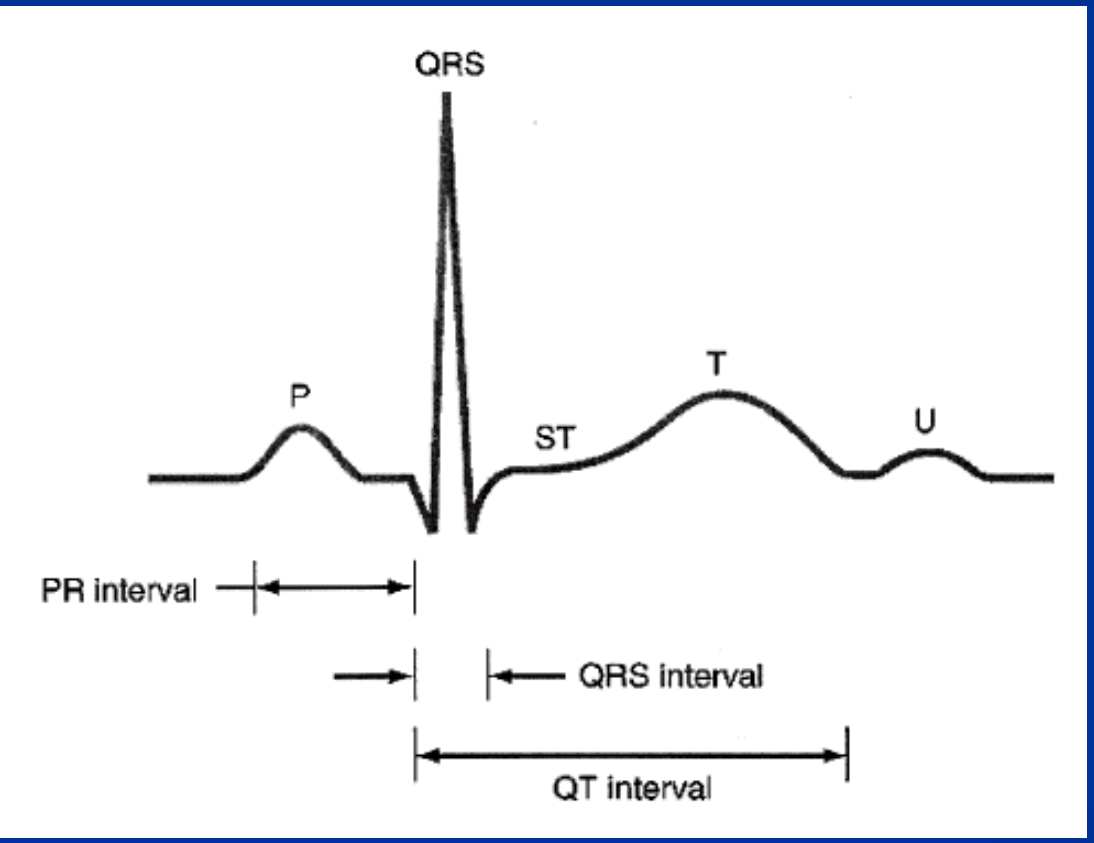




Sensitivity low –
QRS and some T waves will be sensed by pacemaker as a QRS

http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif

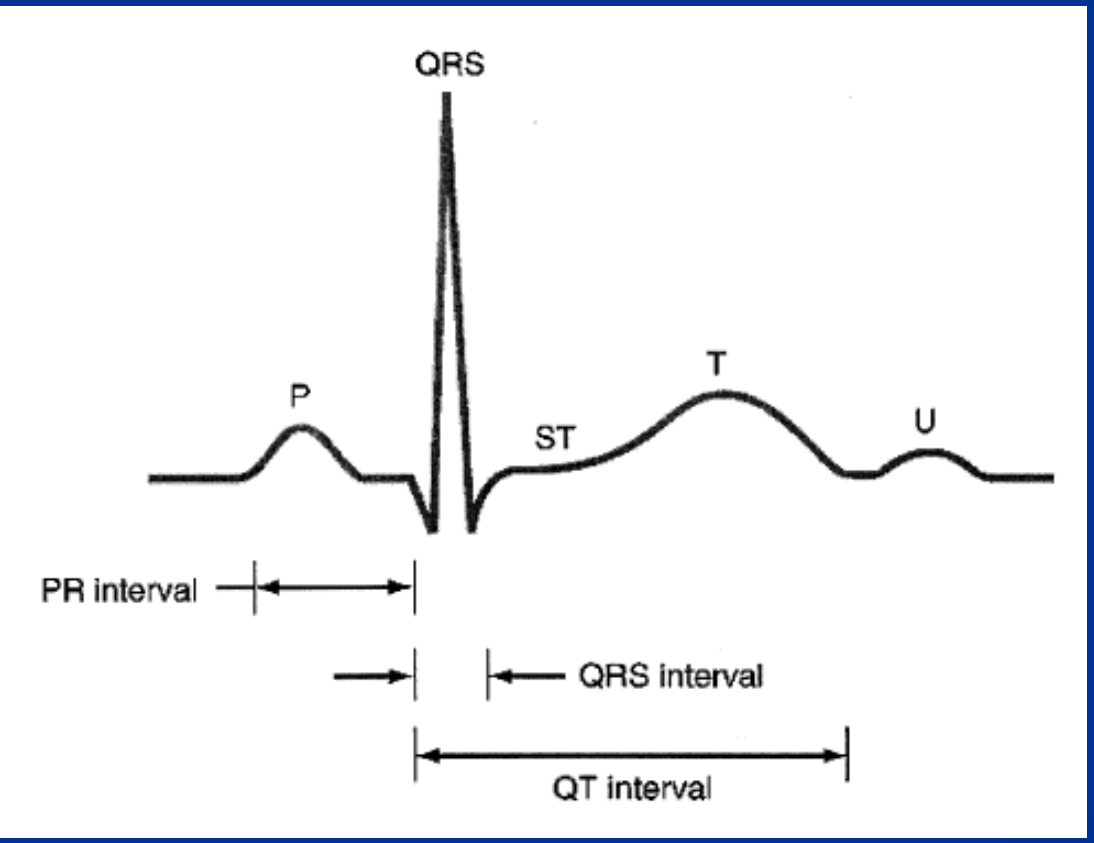
Sensitivity



Sensitivity just right
QRS will be sensed,
T waves will not

http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif

Sensitivity



Sensitivity too high
Nothing will be sensed

http://www.univie.ac.at/cga/courses/BE513/EKG/qrs.gif

Testing thresholds

- Output Threshold
  - Set Sensitivity to 'asynchronous'
  - Set Rate just above the native heart rate
    - 60-80 bpm
  - Start output at 5-10 mA, and gradually turn down until ventricular capture is lost
  - The last point before losing capture is the threshold
  - Pacemaker output should be set at 2-3x the threshold

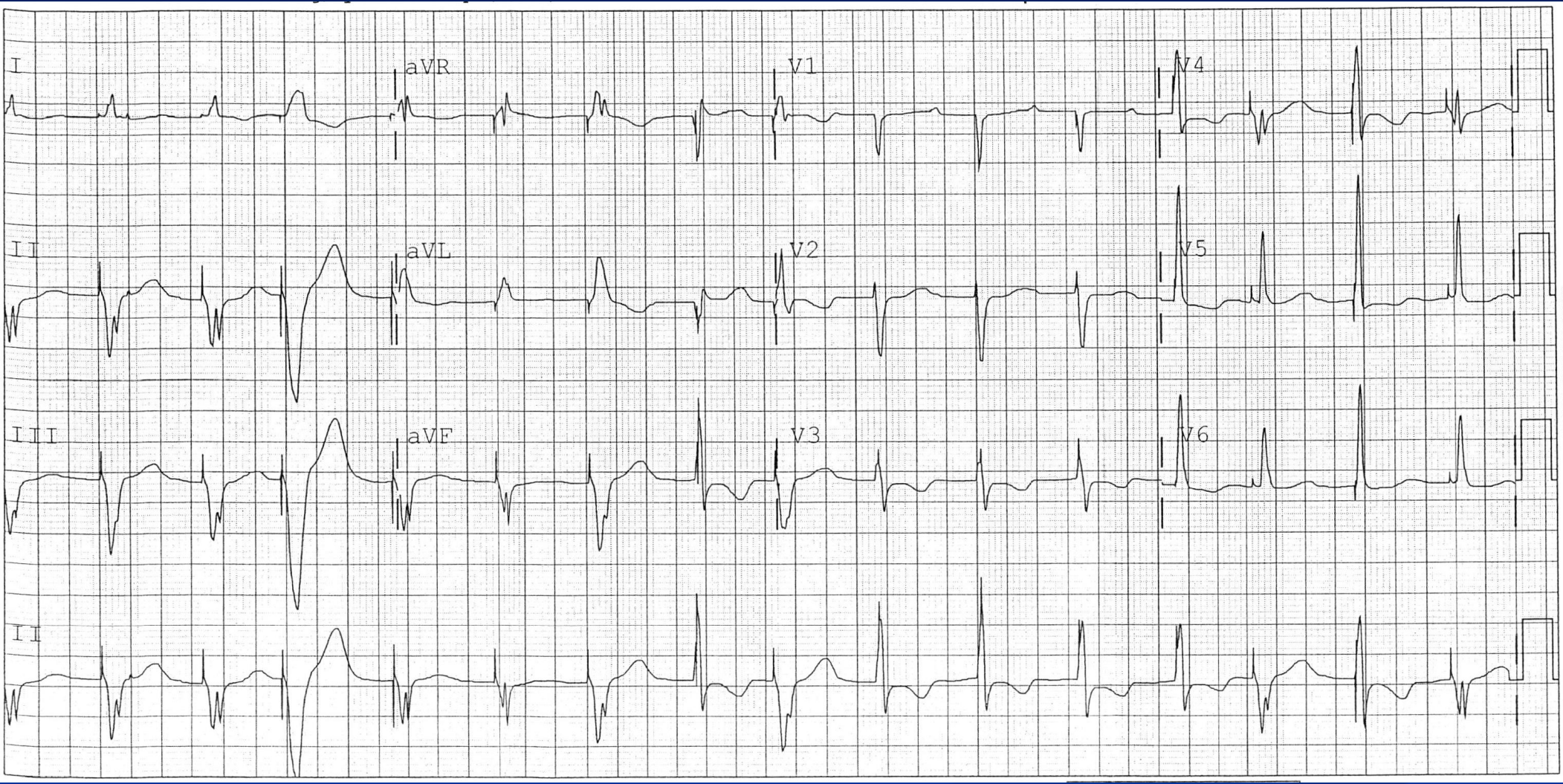
Testing Thresholds

- Sensitivity Threshold
  - Not always necessary
  - Testing the amplitude of native QRS complexes as seen by the can
  - Set Rate just below native heart rate
  - Set Output at 2-3x the Pacing threshold
  - Start asynchonrous, then slowly turn dial down. Pacemaker spikes will disappear when the sensitivity threshold is reached. The pacemaker can now 'see' the native QRS complexes.
  - The pacemaker should be set at a sensitivity 1/3 to 1/2 the sensitivity threshold

Troubleshooting Pacemakers

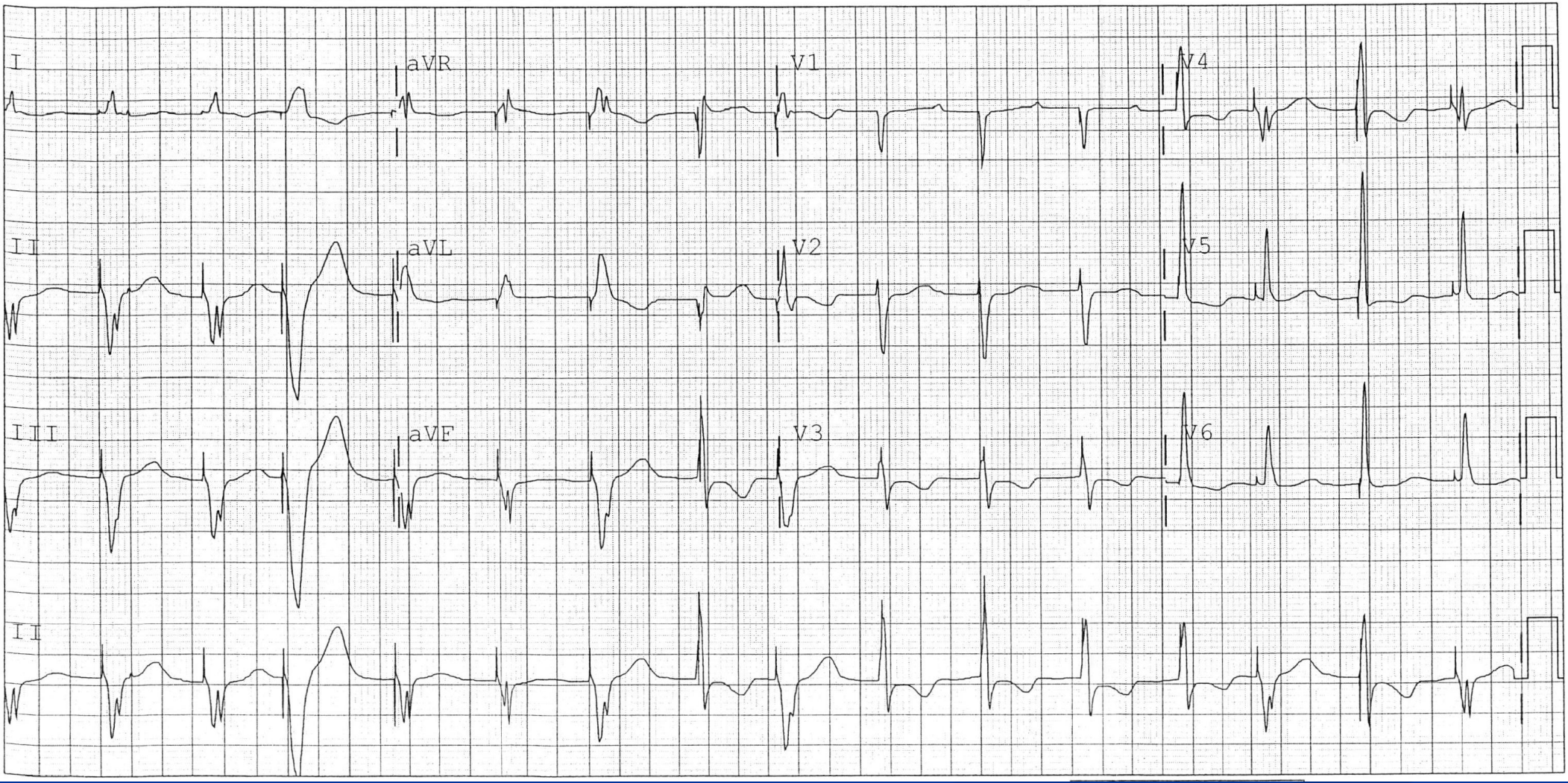
- Normal behavior that looks strange
- Failure to Capture
- Undersensing
- Oversensing
- Cross Talk (Dual Chamber only)

Normal behavior of VVI pacemaker



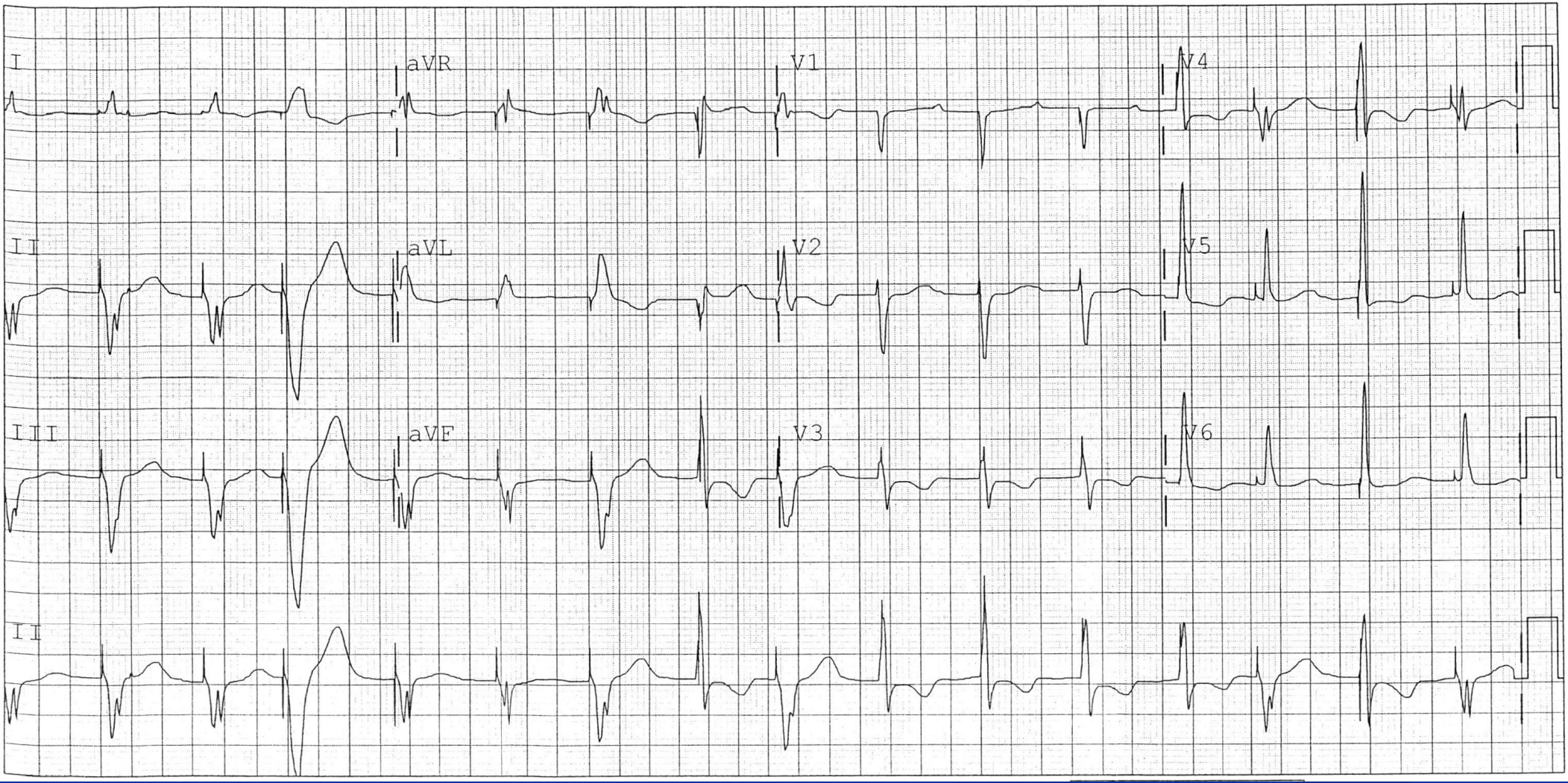
Native QRS

Normal behavior of VVI pacemaker



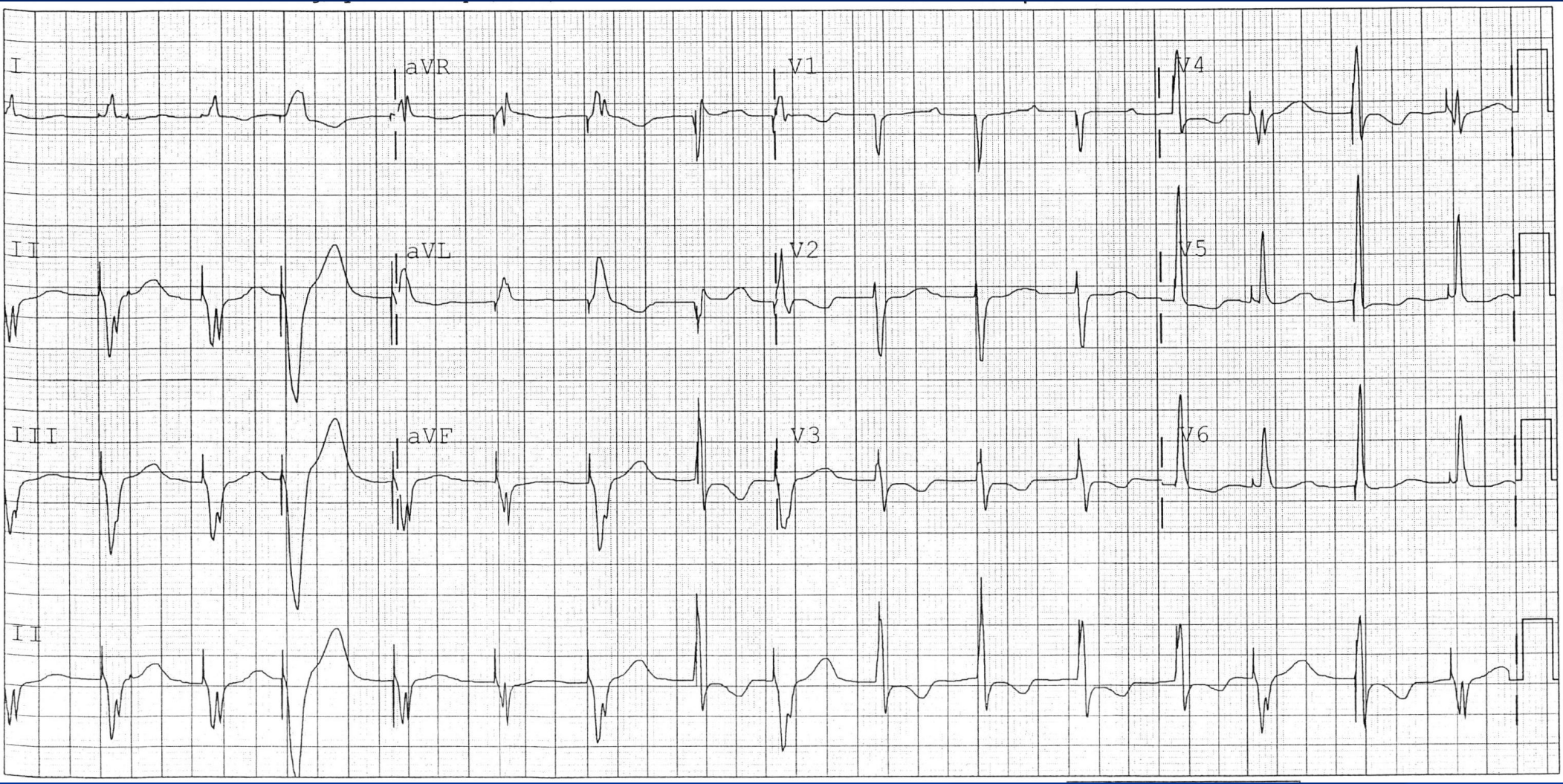
Paced beat with capture

Normal behavior of VVI pacemaker



Fusion beat – combination of native QRS and paced beat

Normal behavior of VVI pacemaker



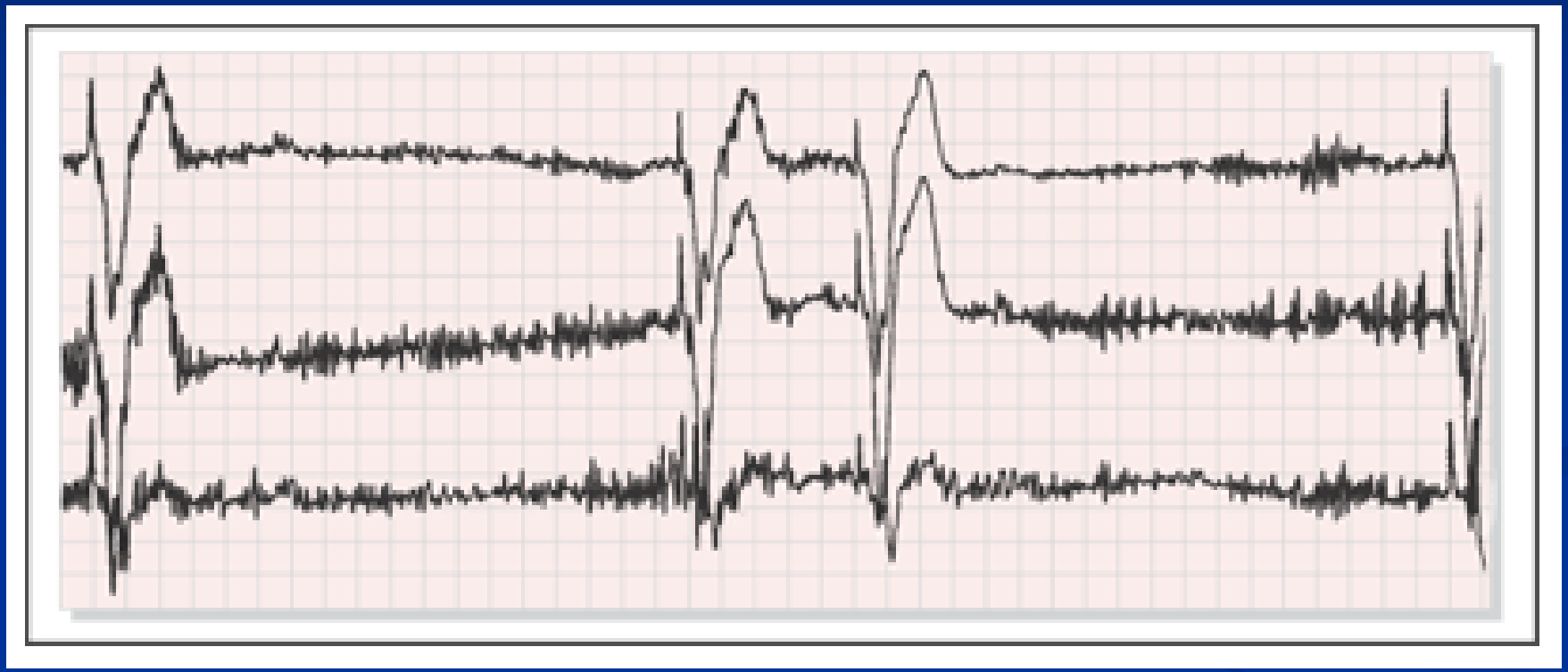
Pseudofusion – pacing spike, normal QRS

Failure to Capture

Braunwald, 7th ed.

Atrial pacing with intermittent ventricular capture

Failure of output (oversensing)



Braunwald, 7th ed.

VVI pacemaker sensing artifact as ventricular contractions (oversensing)
As a result, the pacemaker does not output

Undersensing

Braunwald, 7th ed.

VVI pacemaker

3rd ventricular beat is a PVC, but it is followed by a pacemaker spike

4th beat is a probably a normal ventricular beat, but it is also followed by a pacer spike

Cross Talk

Braunwald, 7th ed.

Dual chamber pacemaker in DDD mode
3rd atrial pacing spike is not followed by ventricular spike
Ventricular lead detects the atrial spike as a ventricular depolarization,
So the pacemaker fails to deliver a ventricular spike