FACULTY/PRESENTER DISCLOSURE

- Faculty: Arnold Pinter
- Relationships with commercial interests:
  - Grants/Research Support: Sorin Canada
  - Speakers Bureau/Honoraria: Medtronic Canada (>10 yrs ago)
  - Consulting Fees: None
  - Other: None

Personal disclosure:

- I have seen device ECGs that I could not figure out

- I like to have fun (by tricking unsuspecting people)

ECG in Cardiac Devices …and beyond

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St. Michael's Hospital

Objectives

- To provide an organized approach to ECG in device pts
- To help with paced ECG troubleshooting
- To show examples of less common pacing modes/features
- To discuss cases interactively
- To have fun

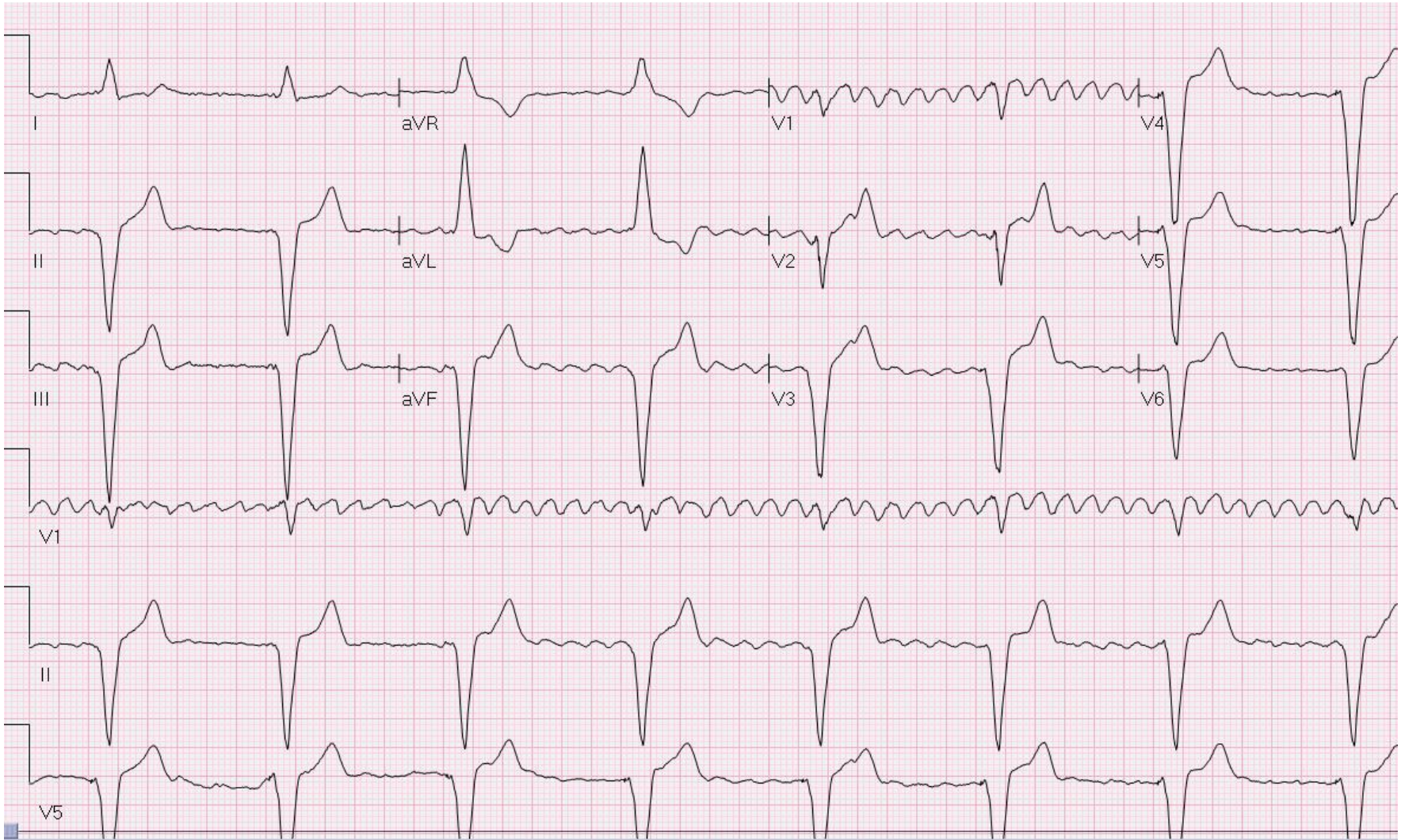
Did you attend the same session at last year's IWAS?

- 1: IWAS here
- 2: IWAS not here

Approach to the ECG of cardiac devices: 6 “easy” steps

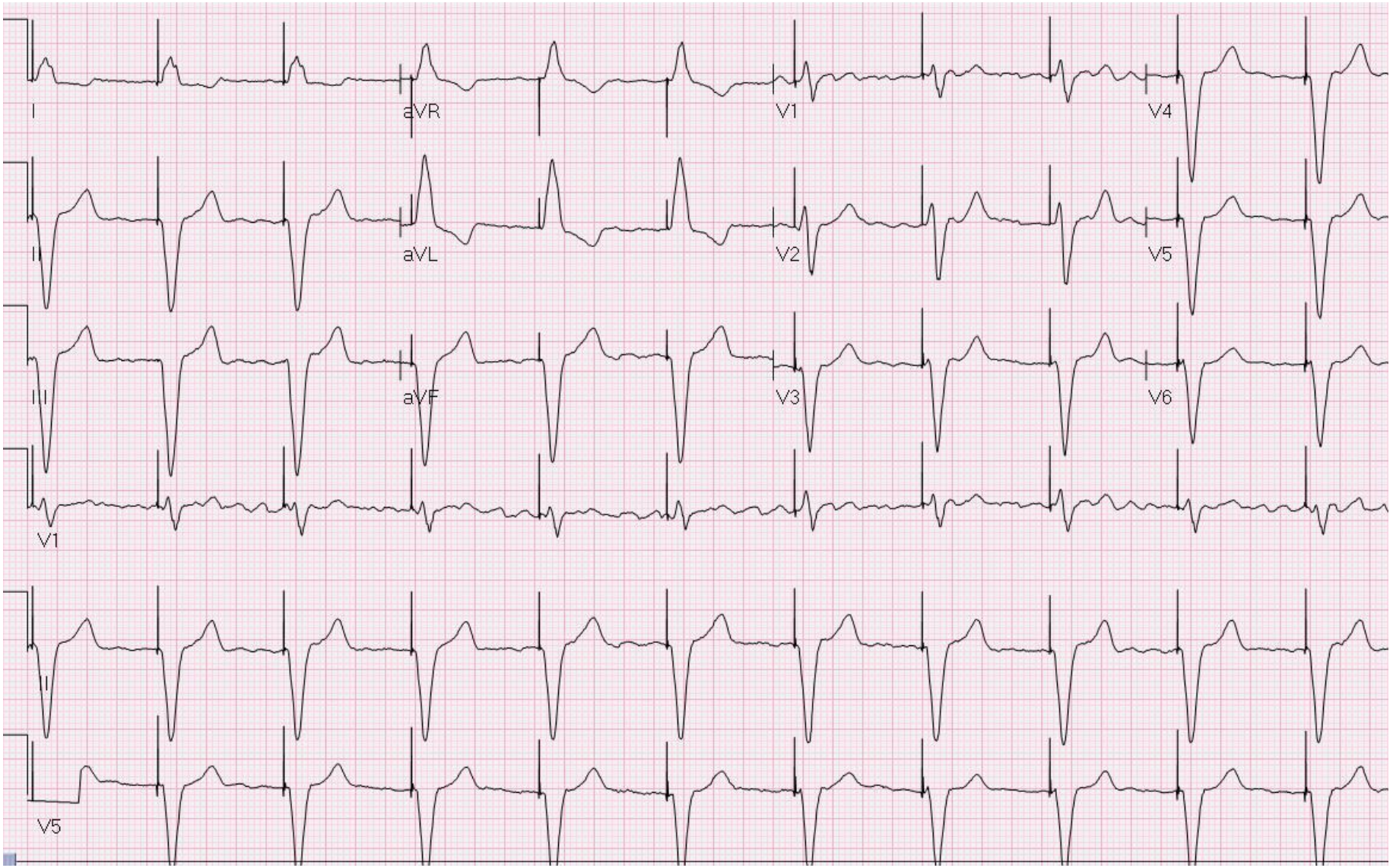
- Step 0. What are we looking at?
- Step 1. Is there evidence for a pacemaker/ICD?
- Step 2. Type of device (single/dual/CRT)
- Step 3. Pacing mode?
- Step 4. Capture/sensing?
- Step 5. Special device function?
- Step 6. What is there beyond pacing?

82 yo man with a history of atrial fibrillation and LBBB.
Recent episodes of fall, possible syncope.
Holter monitoring showed transient CHB with presyncope.
Echocardiogram showed normal LV function.
This is his last ECG.
Question: Do you think he should get a pacemaker? (Answer: 1. Yes; 2. No)



Same history.

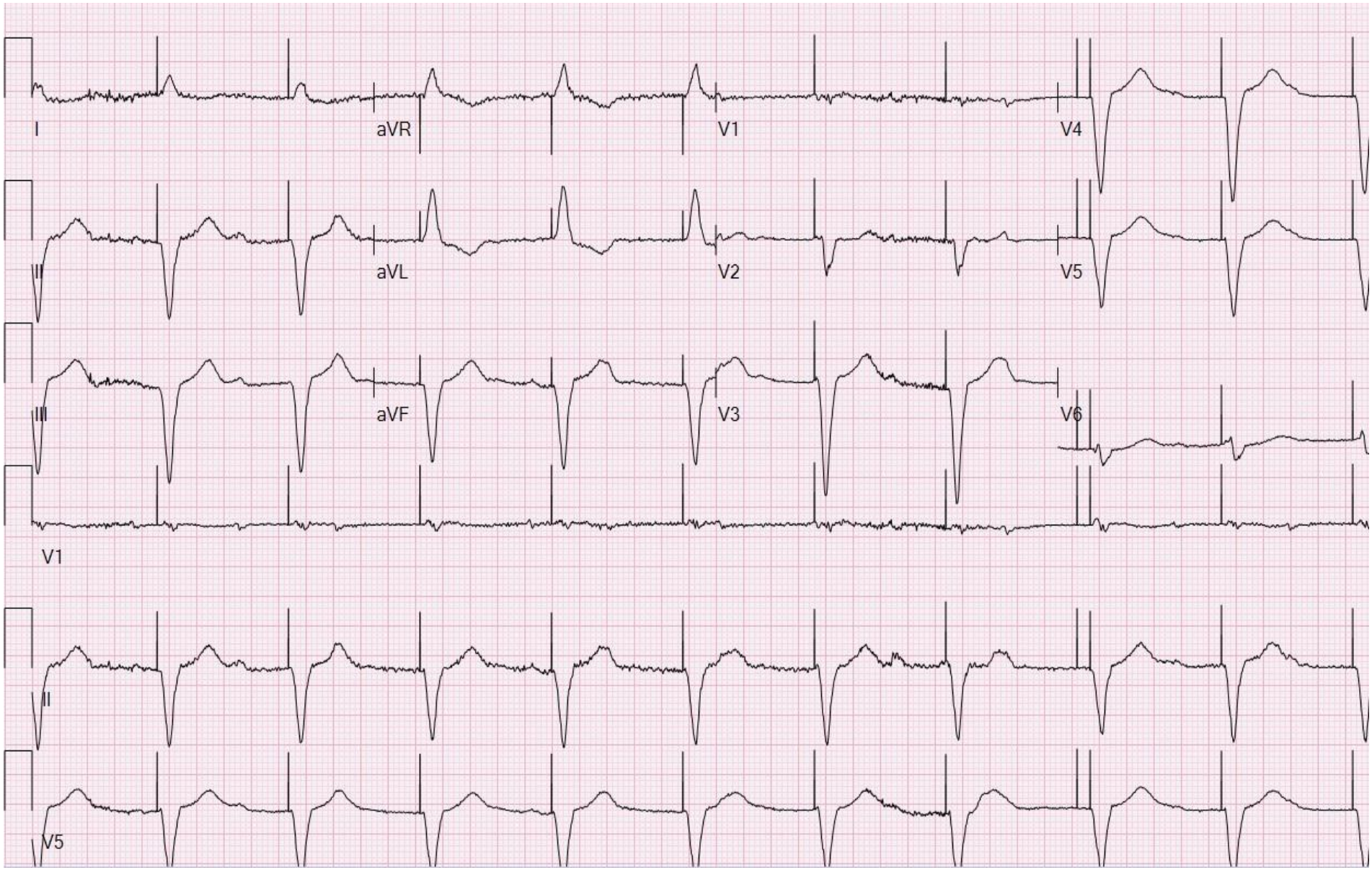
Same question: Do you think this patient should get a pacemaker?



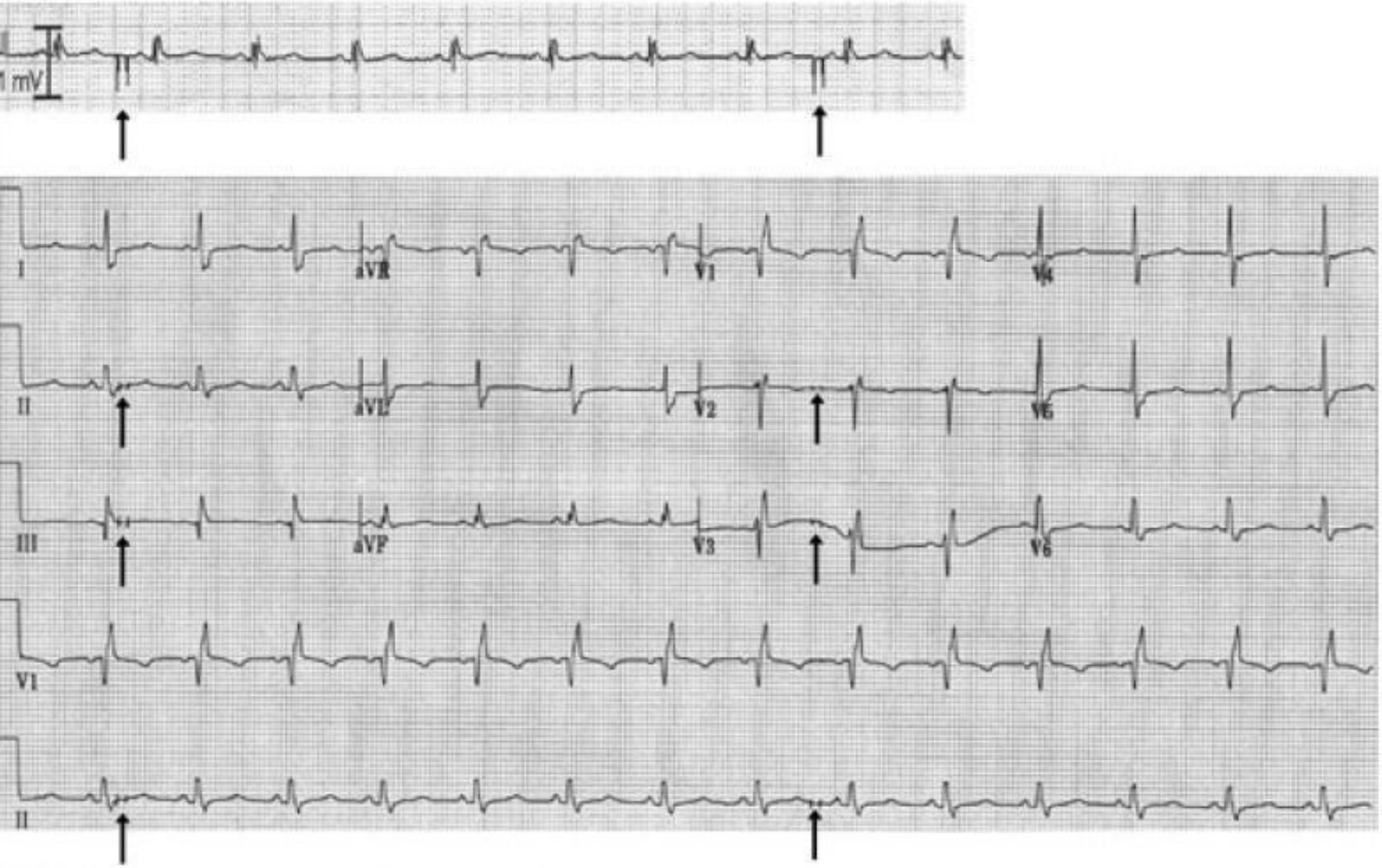
Step 1. Is there ECG evidence for a pacemaker/ICD?

- Can you see spikes?
  - If yes, are they
    - Cardiac pacing spikes?
    - Noncardiac pacing spikes?
    - EMI/artefacts?
  - If no,
    - Are there invisible spikes?
      - Use magnifying glass
      - Look at ventricular rate and QRS morphology
    - No spikes (Magnet ECG)

Question: Is it 1. single chamber or 2. dual chamber pacing?



What type of pacemaker is this?



Iyer et al. PACE 2012; 35:e203

Iyer et al. PACE 2012; 35:e203

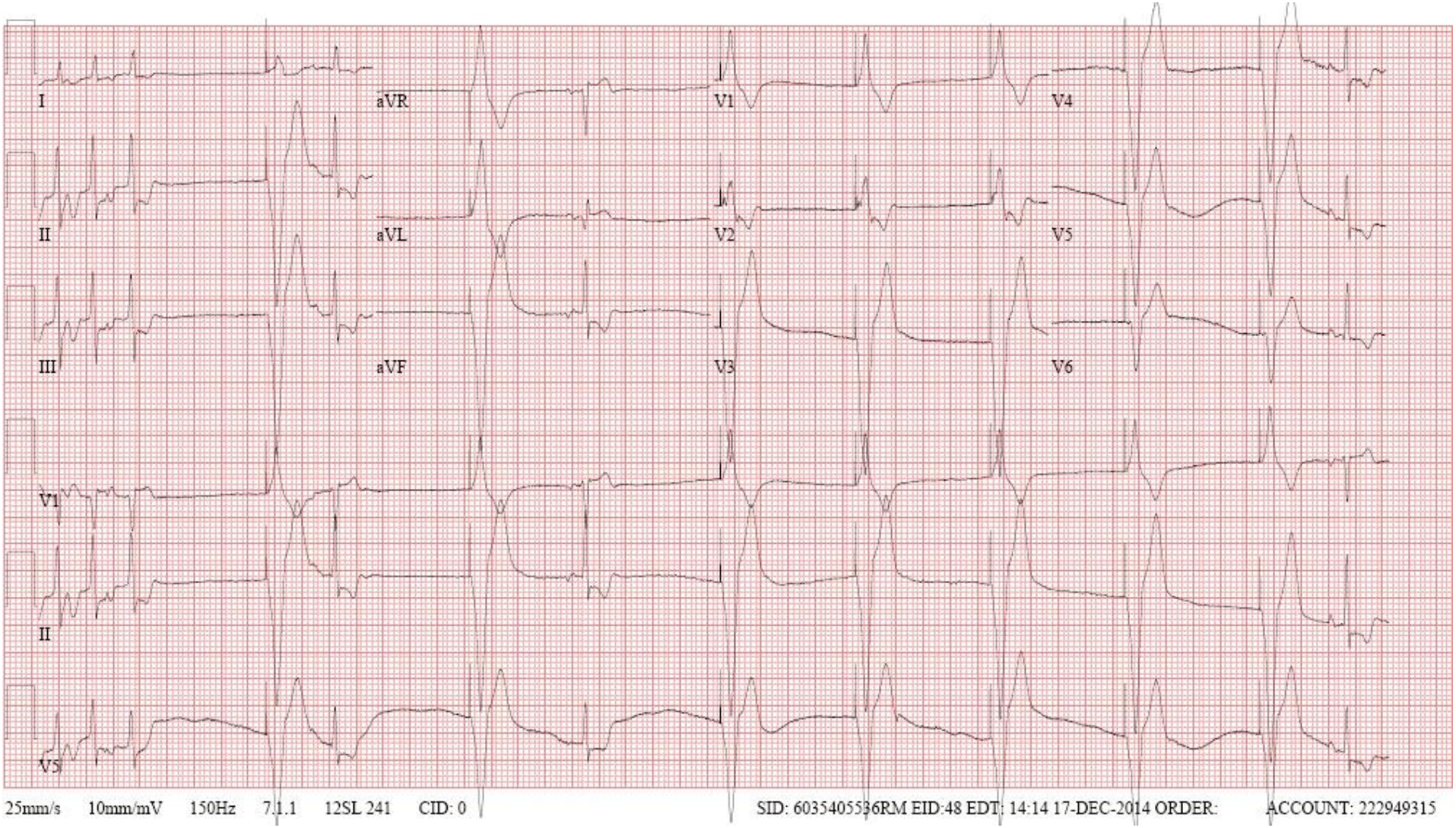
Artefacts that look like pacing artefacts

Step 2. Type of device (single/dual/CRT)

- Useful hints:
  - Tracking atrial activity (dual or CRT)
  - *Paced QRS morphology (RV or biV pacing)*
  - Number of true pacing spikes per cardiac cycle
    - 2 ventricular pacing spikes
      - Just for 1 or 2 cycles: backup ventricular safety pacing (110 ms)
      - Consistently: biV pacing

Consult re: atrial flutter rate control

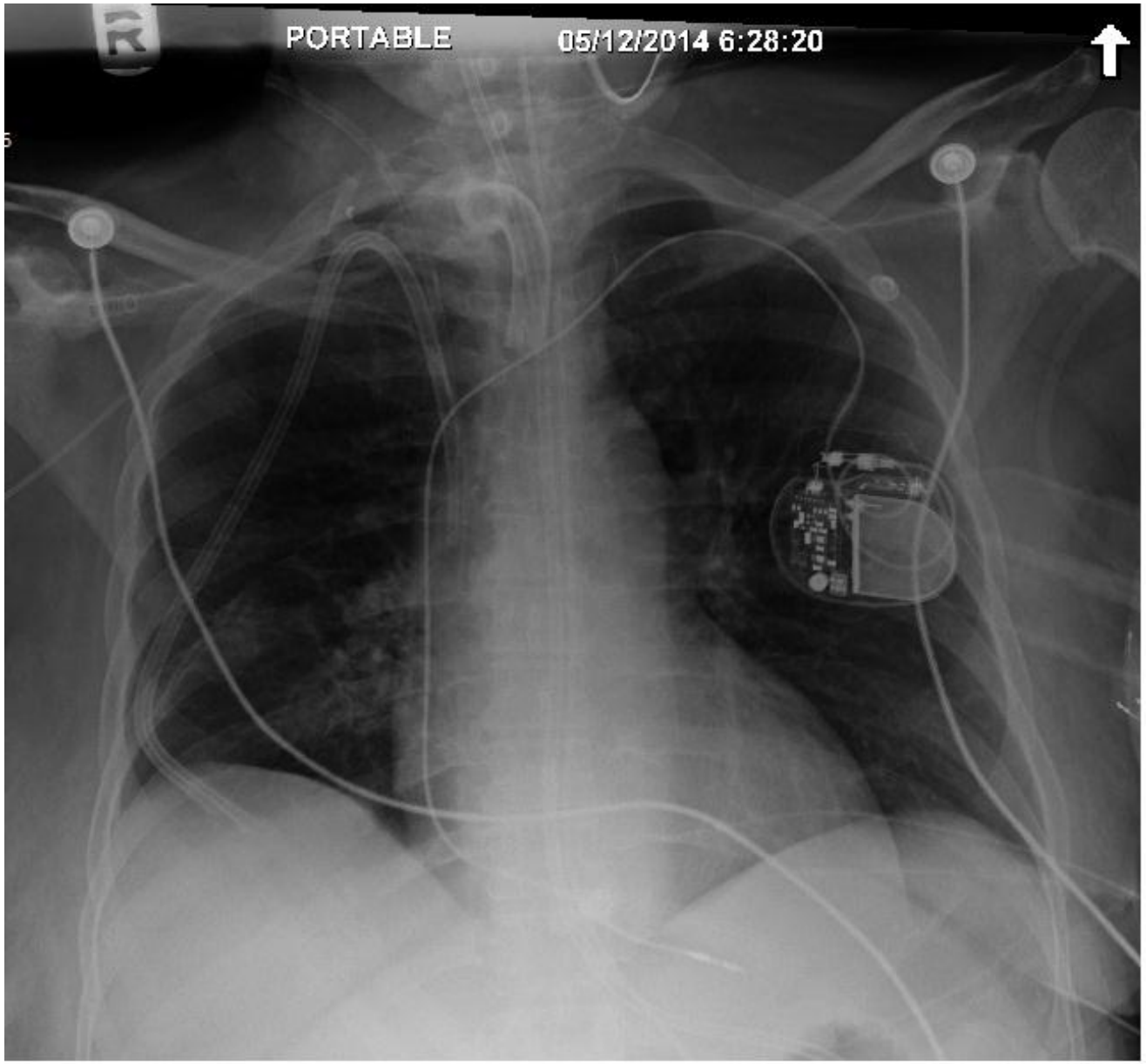
Question: 1. normal VVI 2. abnormal VVI 3. normal DDD 4. abnormal DDD 5. normal CRT 6. abnormal CRT function?



CT scan report

- FINDINGS:
  - Pacemaker lead within the left ventricle.

Postop CXR



Paced RBBB pattern in V1:

LV Pacing :

1. Intended:

    CRT pacing

2. Unintended

    a, Perforation of the RV septal or free wall

    b, Inadvertent positioning of the V lead in the CS or LV through a retrograde transarterial or intracardiac defects such as a PFO, ASD, VSD

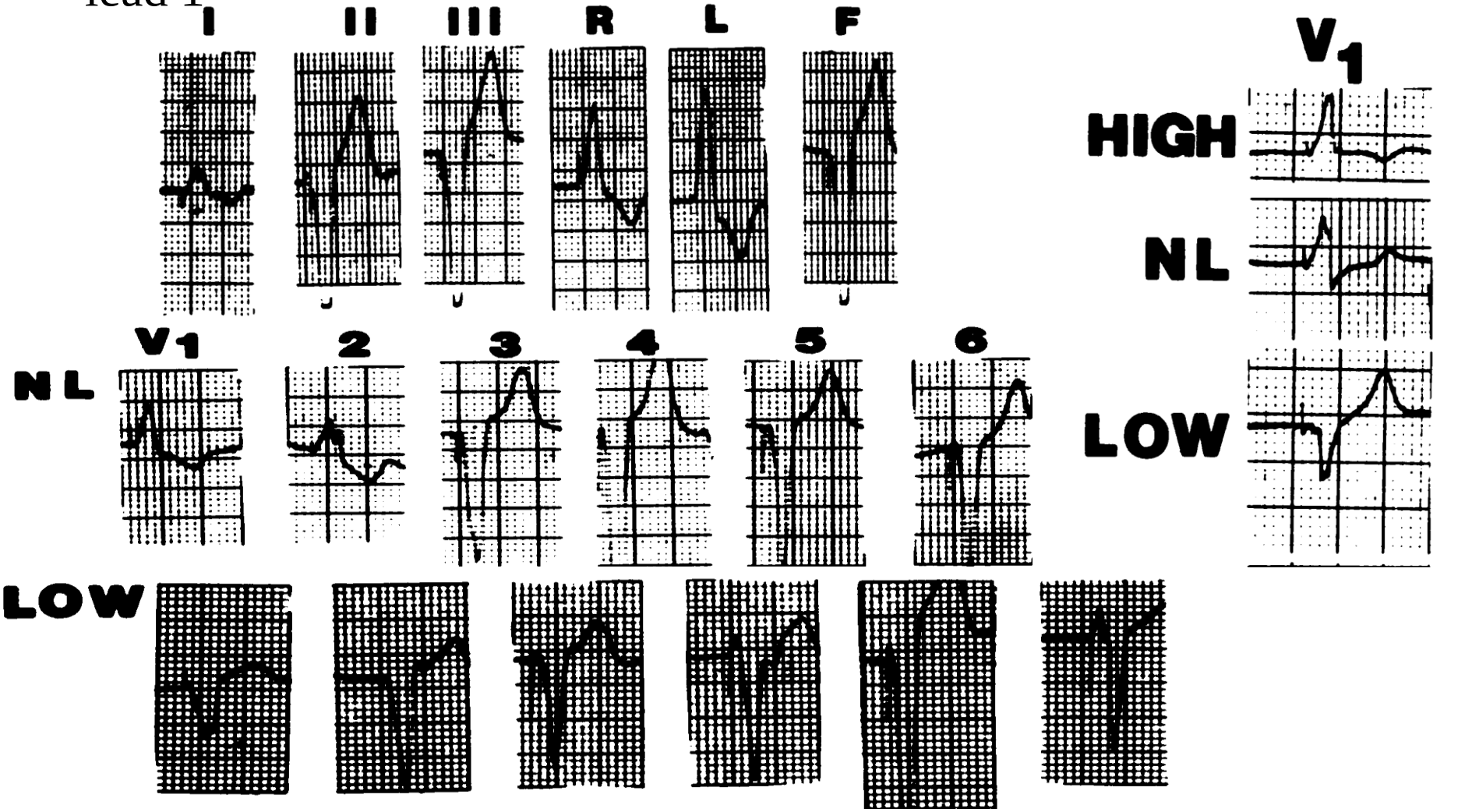
RV pacing:

sometimes occurs with correct placement of lead

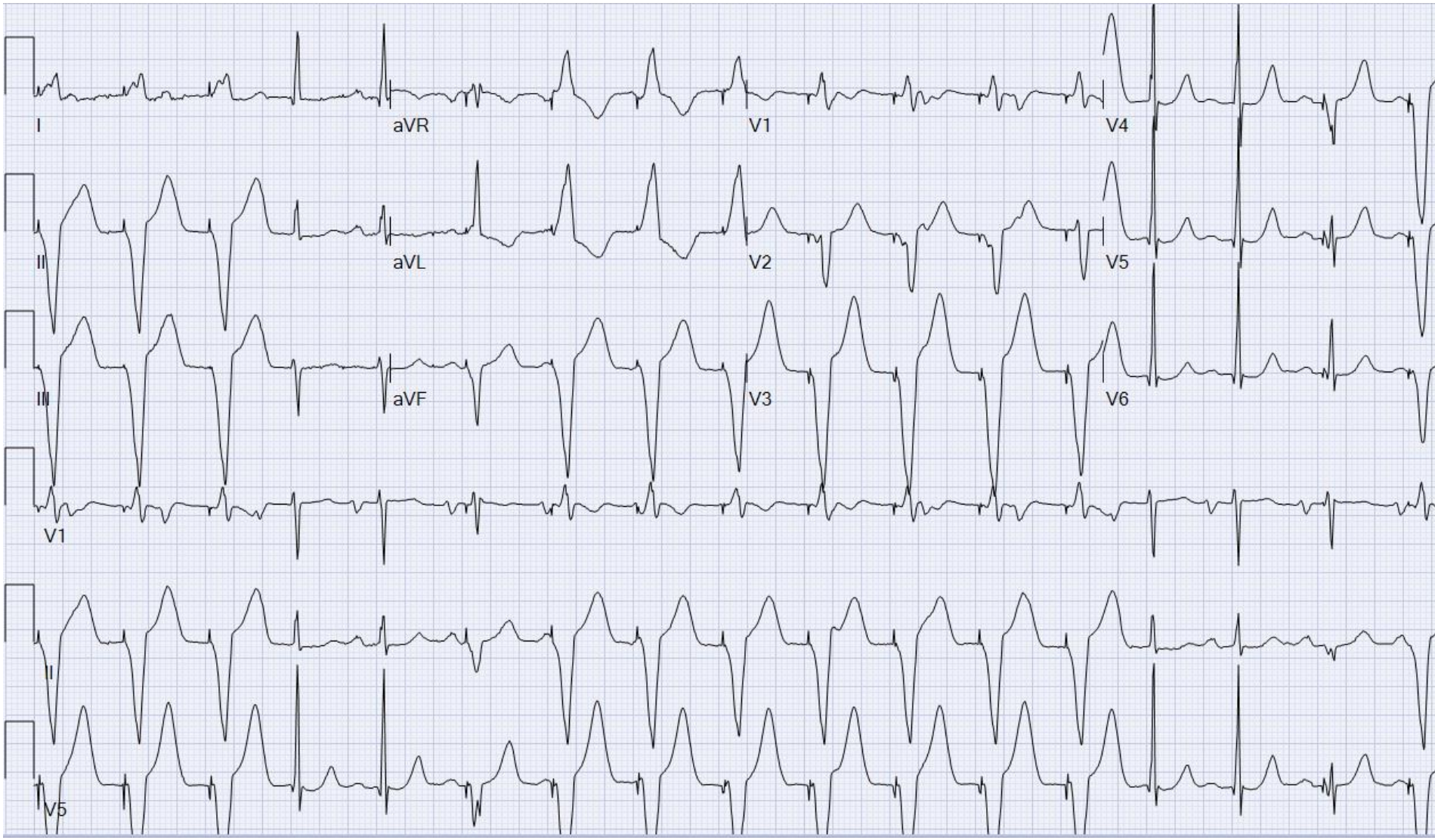
Elimination of RBBB appearance with placement of leads V1 and V2 one interspace lower than standard

Chest 1985; 87:517–521

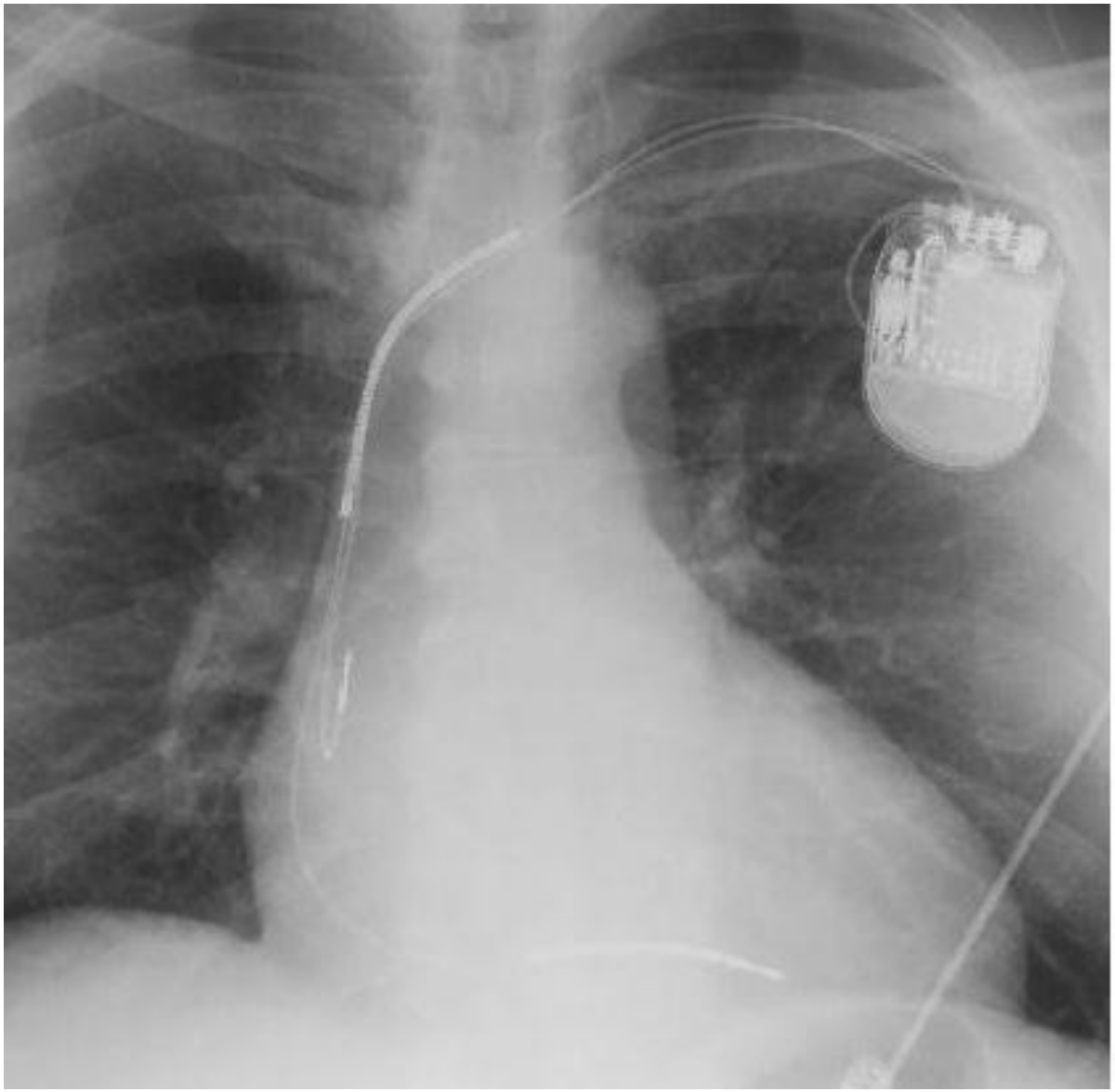
Pseudo RBBB: RBBB in V1-V2 + LBBB in lead 1



Low V1-V2 (5^{th} intercostal space)

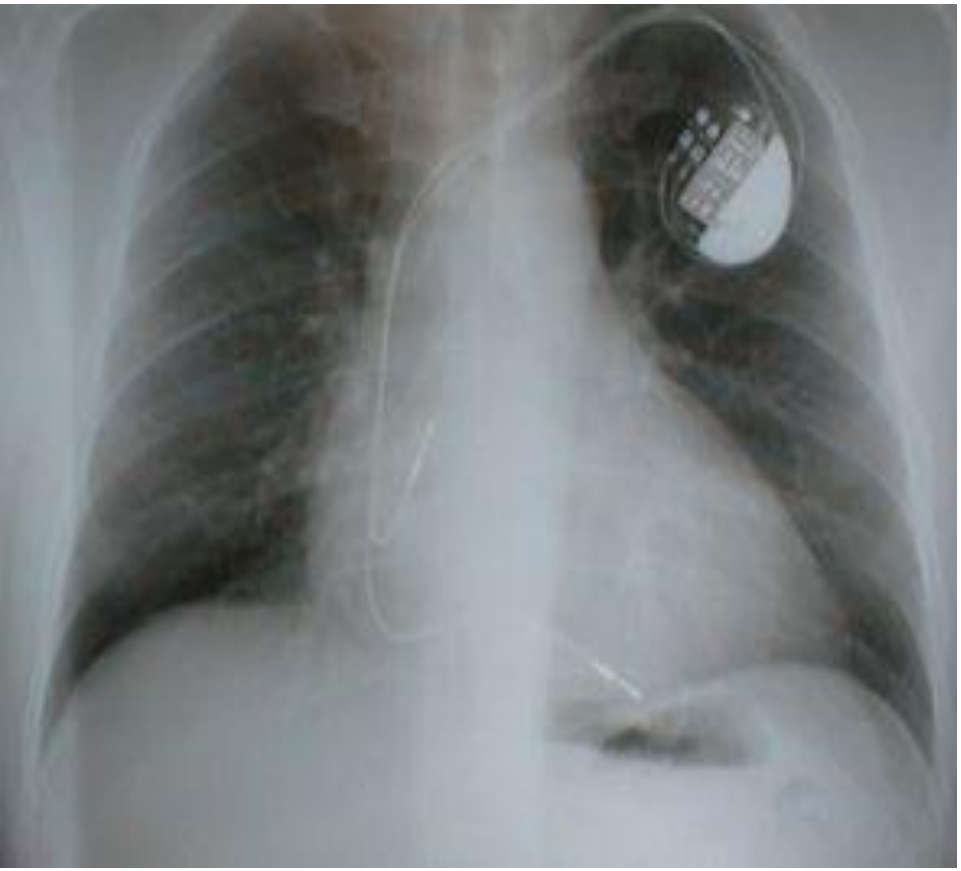


How about this one?

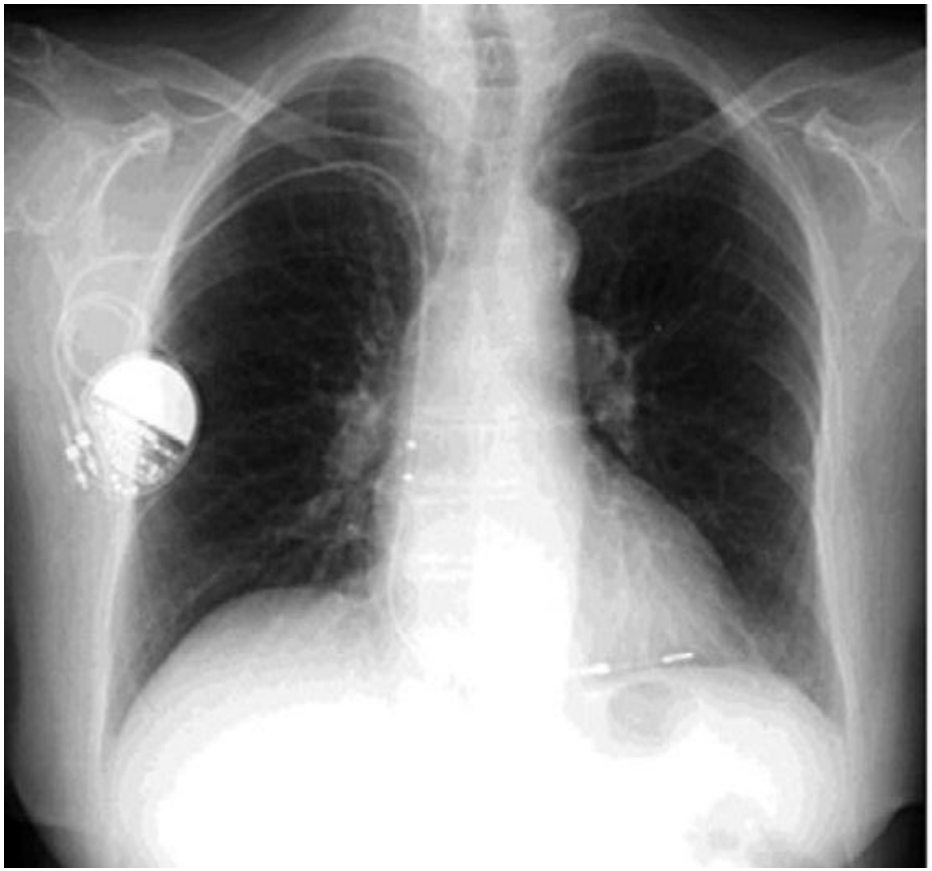


Mix and match Part 2: the X-rays

A



B



Step 3. Pacing mode

- Normally it’s tracking and demand
- Non-demand
  - End-of-life behaviour
  - Temporarily (cautery, etc)
- Non-tracking (DDI)
  - Atrial tachycardia
- Non-pacing (VDD)

Step 4. Capture and sensing

- Proper capture?
  - Physiologic noncapture
  - Morphology
- Proper sensing?
  - Under- and oversensing
  - Fusion/pseudofusion

Question: Is there proper capture/sensing?

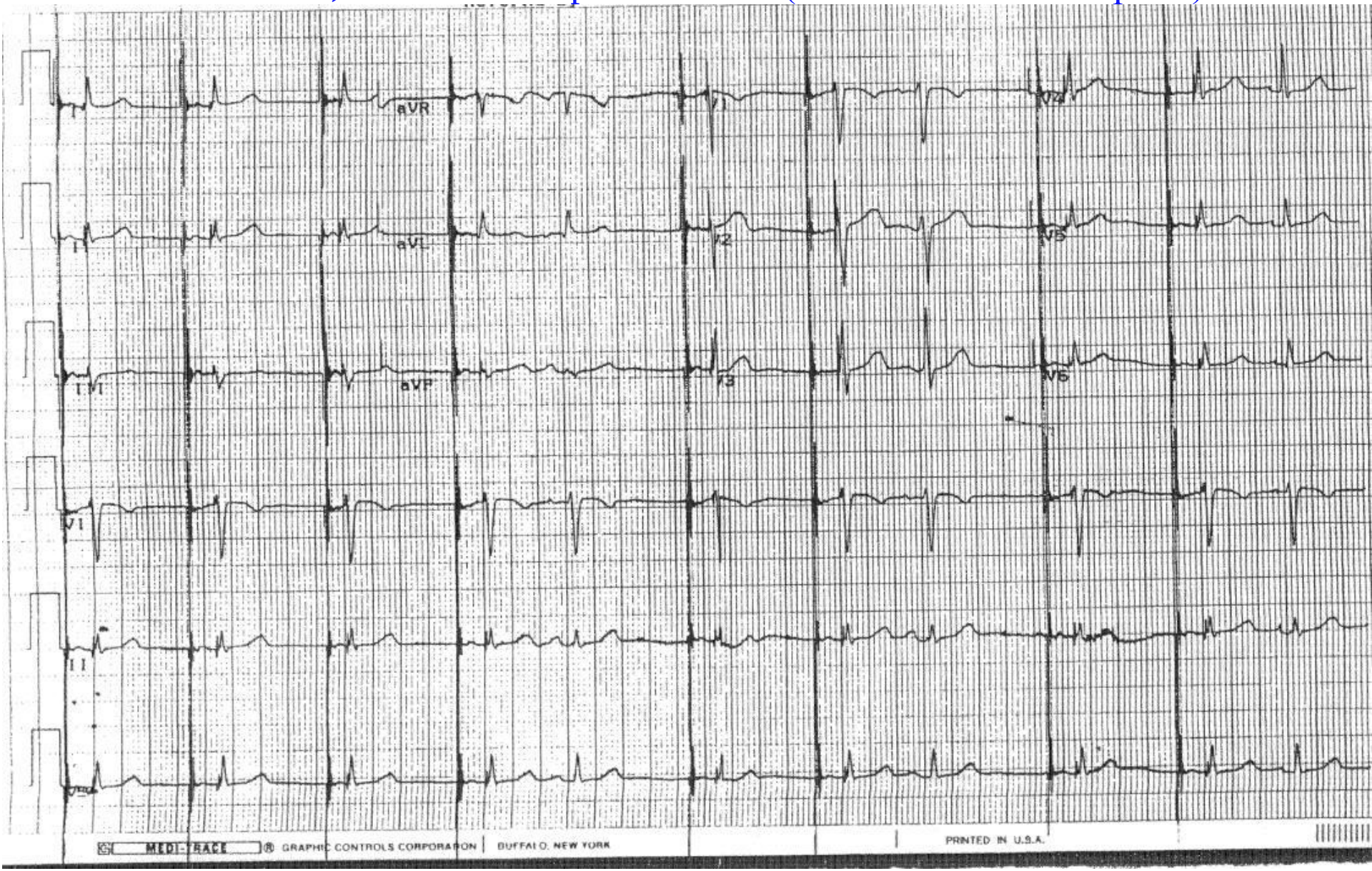
Answer: 1. Yes; 2: No

Question: Is there proper capture/sensing?

Answer: 1. Yes

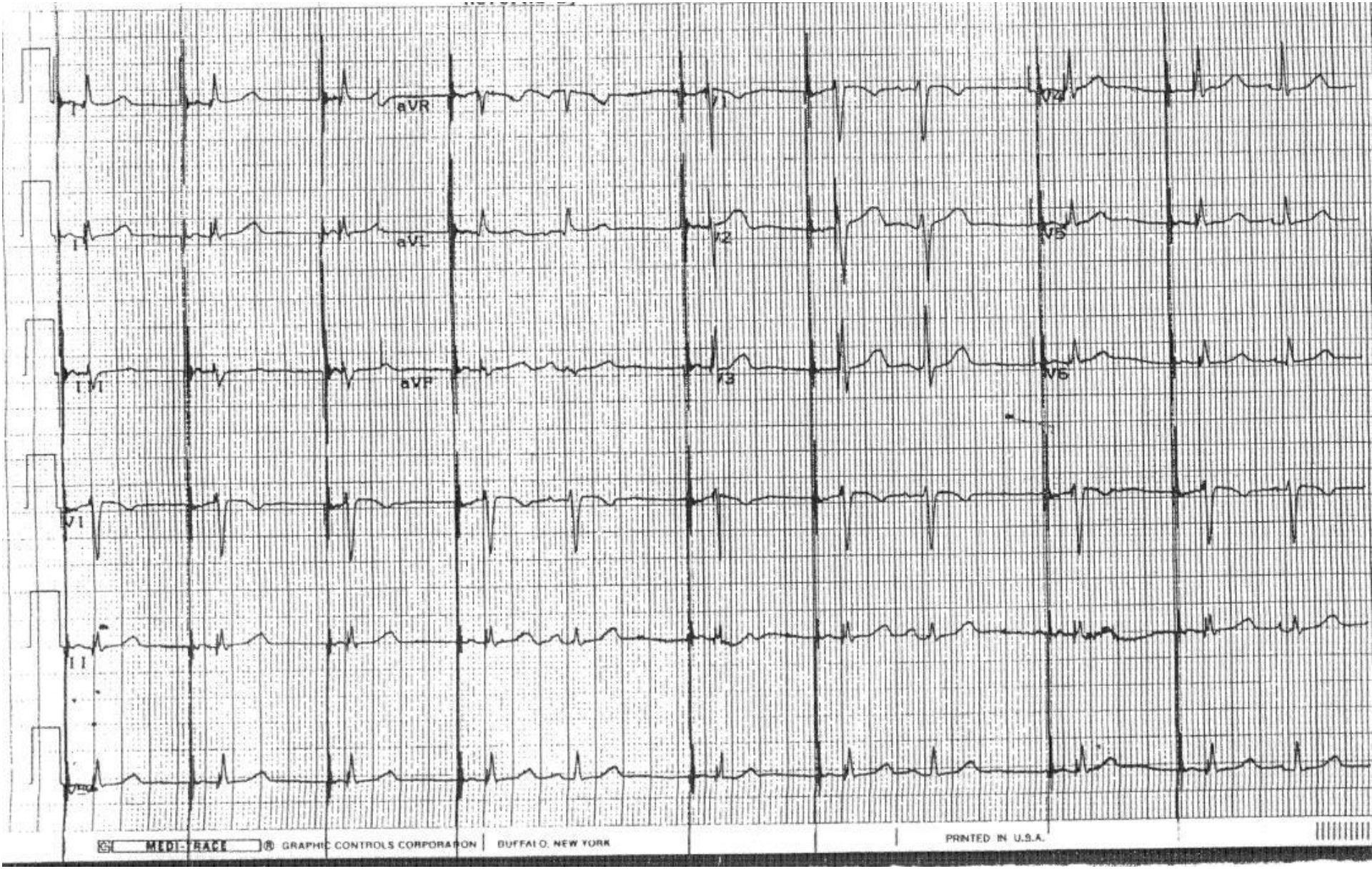
Question: What can you say about the ventricular capture?

Answer: 1. Normal RV capture; 2. Normal biV capture; 3. Normal His bundle capture; 4. Ventricular fusion; 5. Ventricular pseudofusion (can't comment on capture)



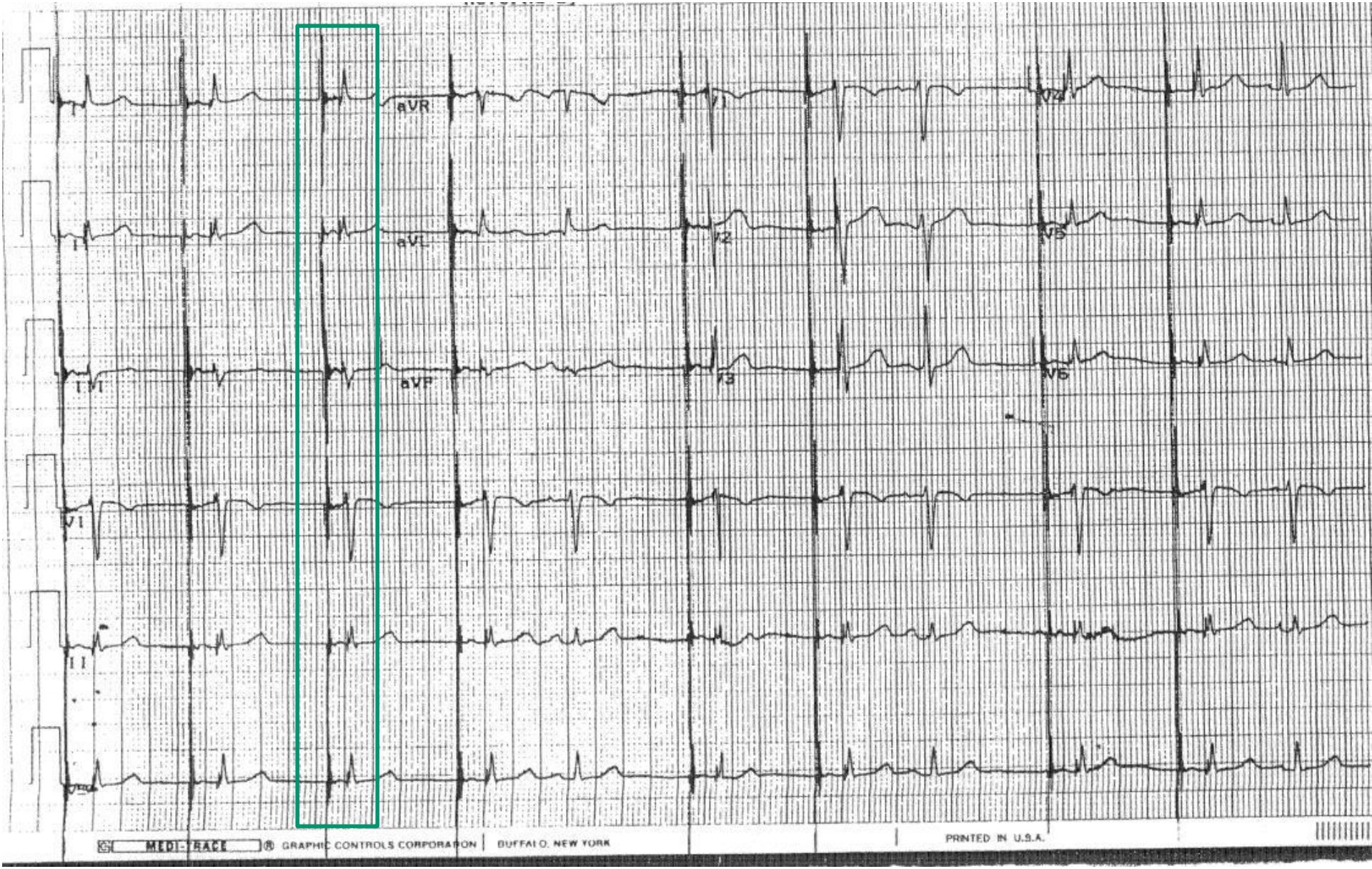
Question: What can you say about the ventricular capture?

Answer: 5. Ventricular pseudofusion (can't comment on capture)



Question: What is the explanation for a shorter (110 ms) paced AV delay in the 3rd beat?

Answer: 1. Ventricular safety pacing; 2. AV search hysteresis; 3. Capture threshold test; 4. Artefact



Step 5. Special device function?

- If communication between the device and the heart is satisfactory (i.e. satisfactory capture and sensing), then usually there is a special device feature that explains the apparently unusual paced ECG
- Exceptions:
  - End-of-life behavior
  - Artefact

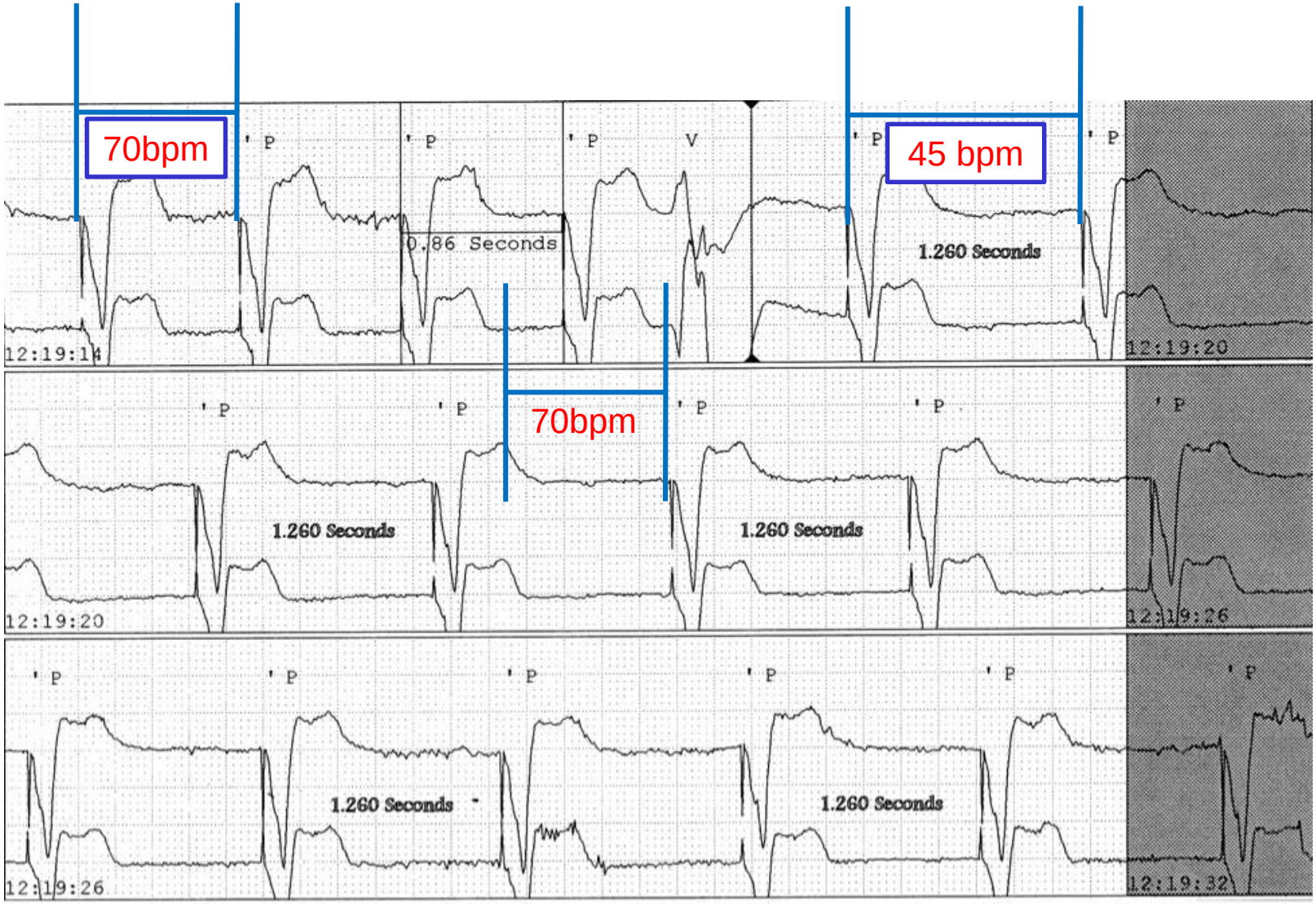
74 year old male with heart failure and paroxysmal AF . Biventricular ICD recently implanted. VVI mode at 70bpm, with max sensor rate 110bpm. Patient returns with worsening heart failure. Telemetry strip recorded during inpatient stay.

Question: Why is the pacing below the Lower Rate Limit?

Answer: 1. Tracking a slow atrial rate; 2. A undersensing; 3. V oversensing; 4. Mode switch

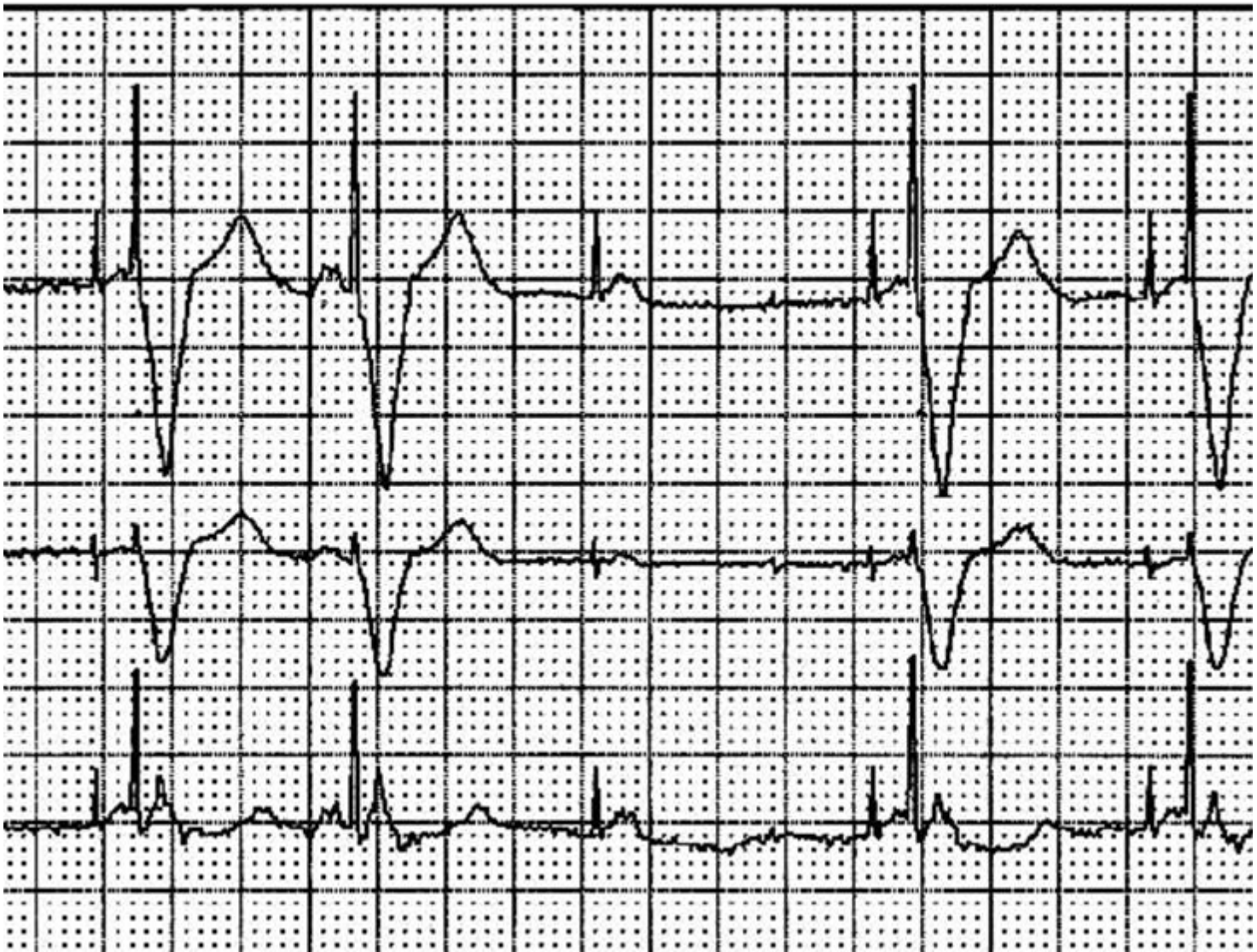
Question: Why is the pacing is below the Lower Rate Limit?

Answer: 3. Ventricular (T wave) oversensing



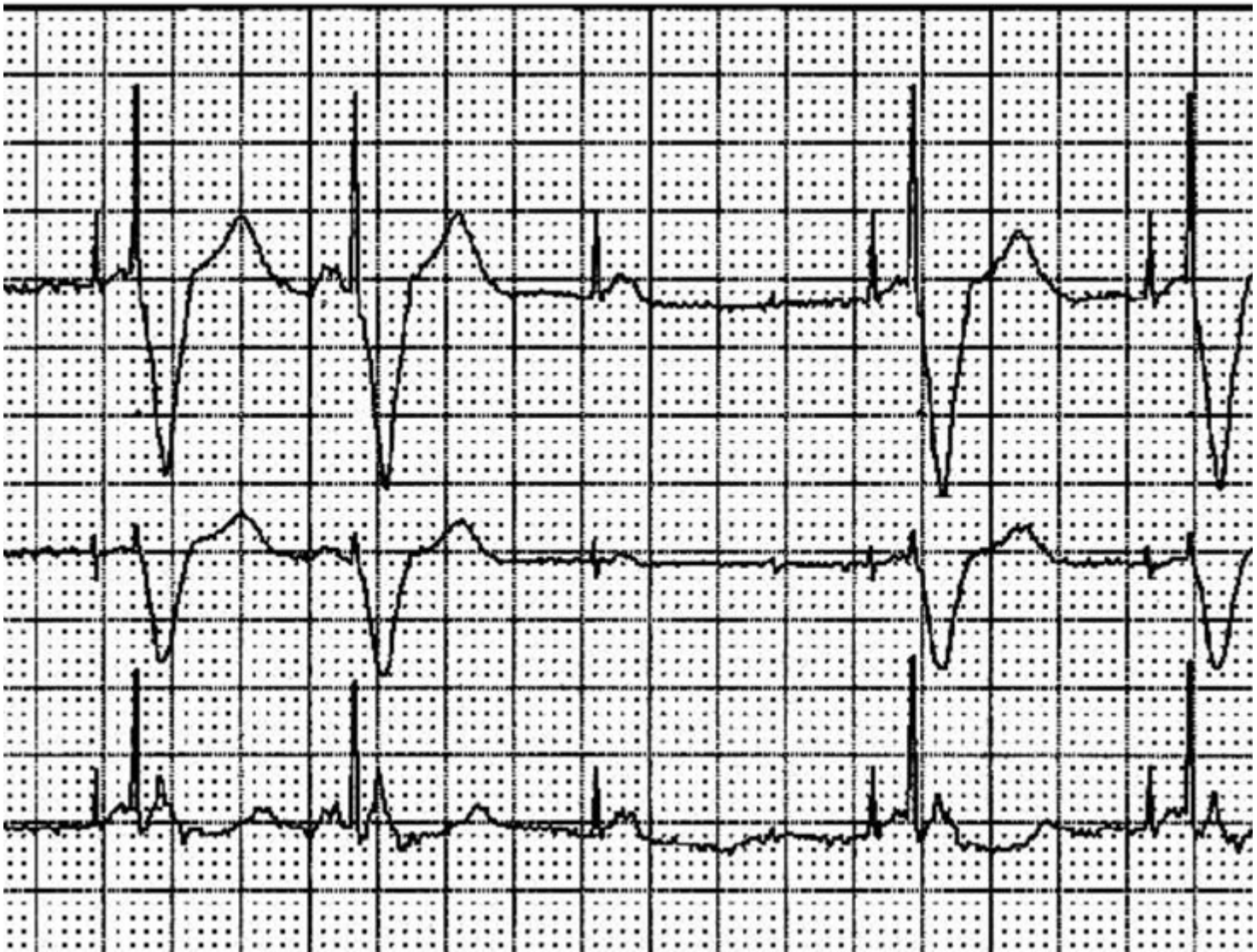
Question: What is the problem with this tracing?

Answer: 1. Crosstalk inhibition; 2. V undersensing; 3. V oversensing; 4. Ventricular safety pacing



Question: What is the problem with this tracing?

Answer: 1. Crosstalk inhibition (3. V oversensing)



Crosstalk

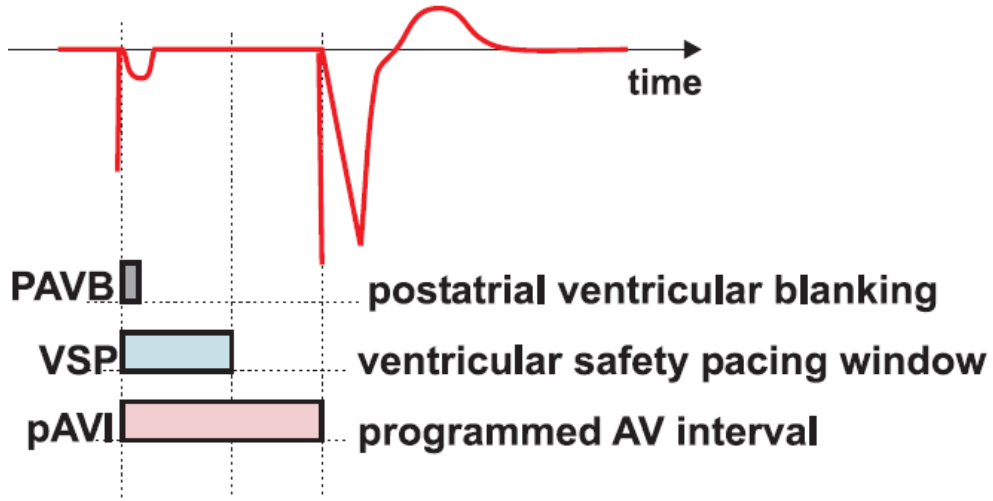
Definition:

- Unwanted detection in one channel of a signal from another channel.

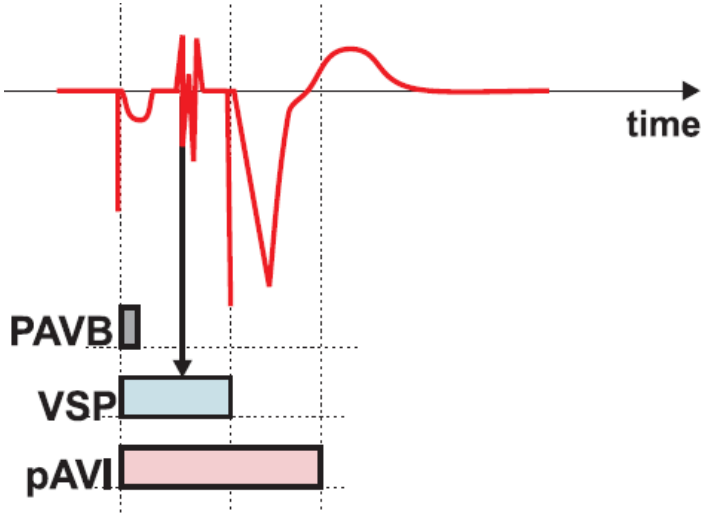
- Most common:
  - Afterpotential from the atrial output sensed by ventricular channel and resets the VA timer

- The consequence of Crosstalk is the withholding of ventricular pacing

Ventricular Safety Pacing



Following an A paced event, a VSP interval is initiated.

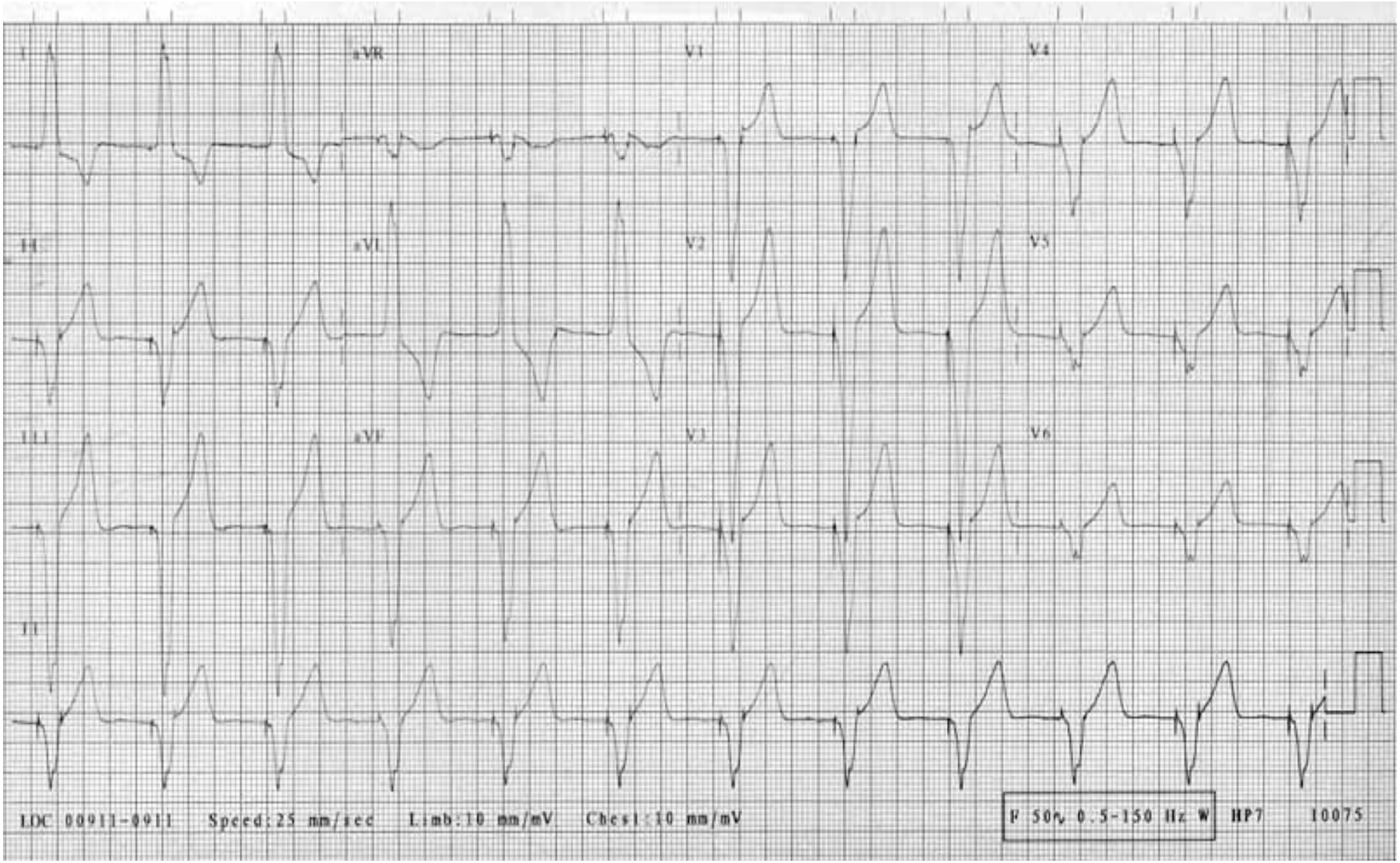


If a V sense occurs within the VSP window a pacing pulse is delivered at 110ms.

(Non physiological AV delay)

Question: What is going on?

Answer: 1. Ventricular safety pacing; 2. CRT pacing with long VV delay; 3. A and V lead switch; 4. Atrial lead dislodgement into the ventricle; 5. 2 PMs; 6. Artefact



Question: What is going on?

Answer: 3. A and V lead switch in pacemaker header