KHRS 2017

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ECG Education Course

AV Node and AV Block

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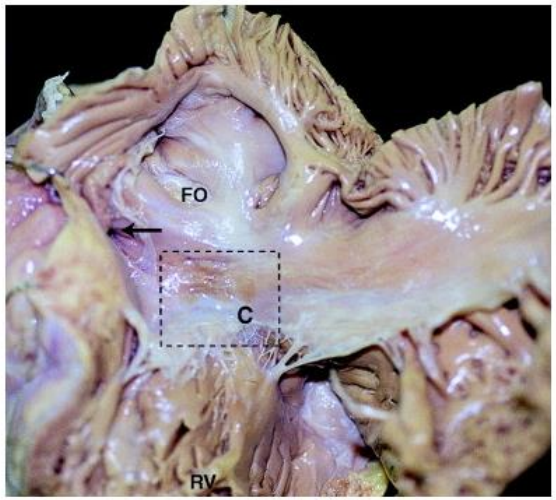
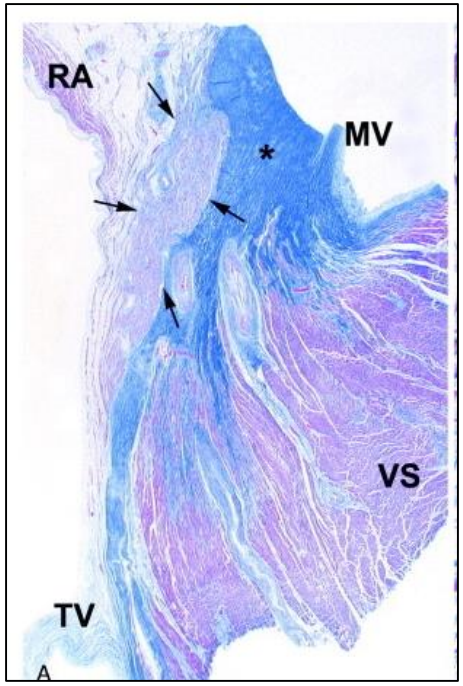
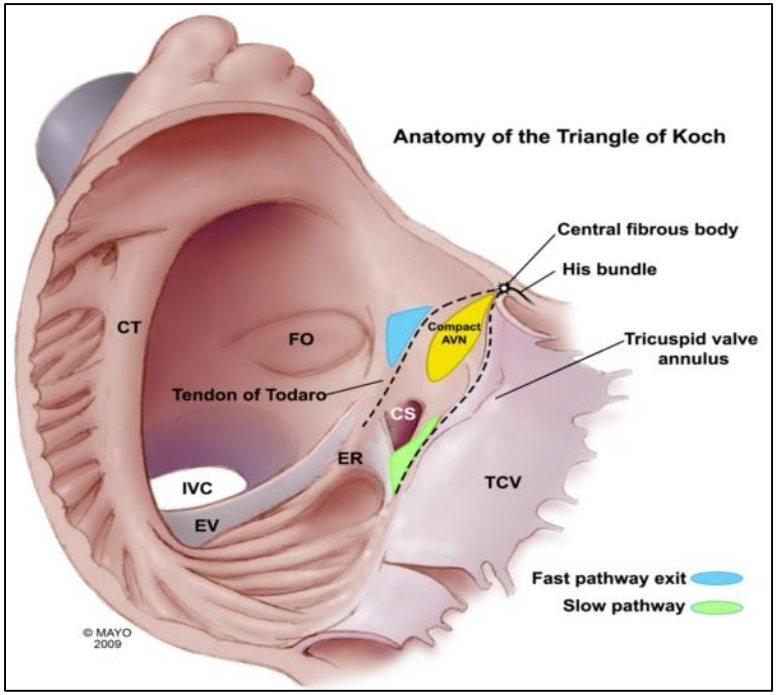
AV node

- ✓ **Compact spindle-shaped network of cells arranged in a “knoten” (node) connected to the His bundle**
- ✓ **Only physiological AV axis of conduction**
- ✓ **The compact AV node is located at the base of the atrial septum in the triangle of Koch (anteriorly by the insetion of the septal leaflet of the TV and posteriorly by eustachian ridge).**
- ✓ **Blood supply : RCA(85-90%), LCx(10-15%)**

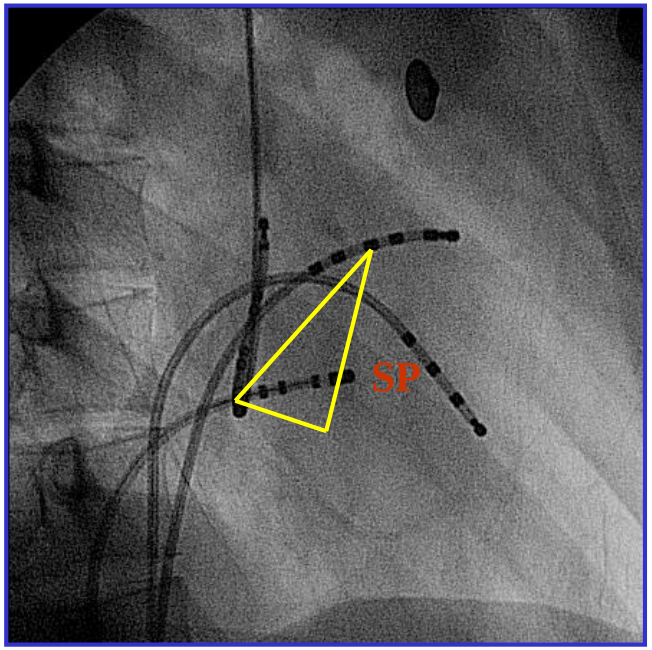


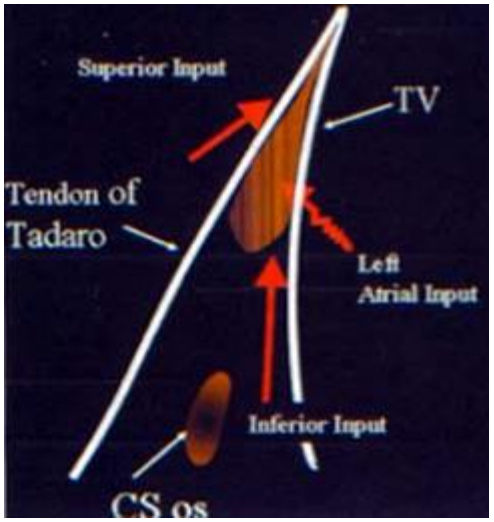


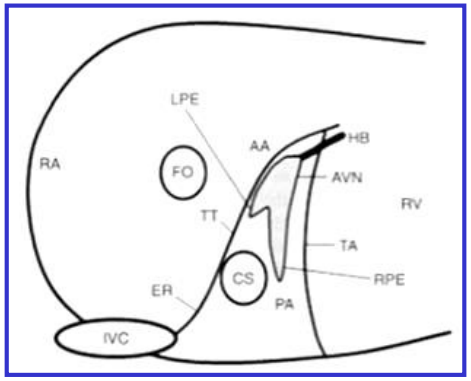


The Triangle of Koch

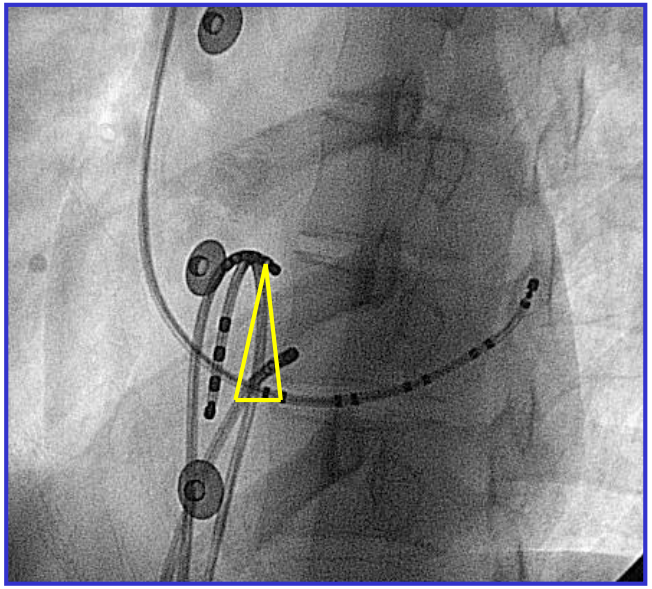
RAO

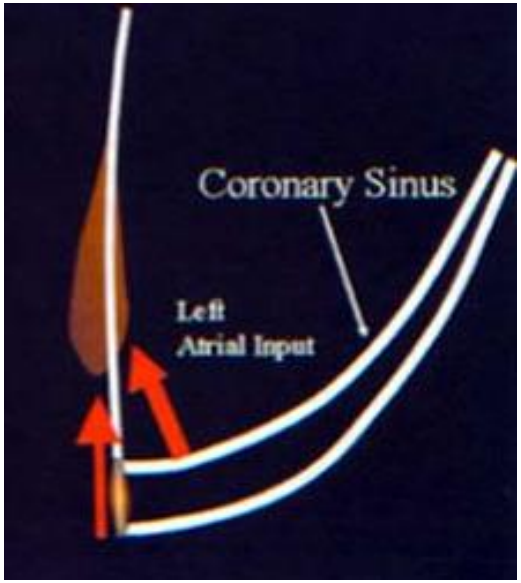


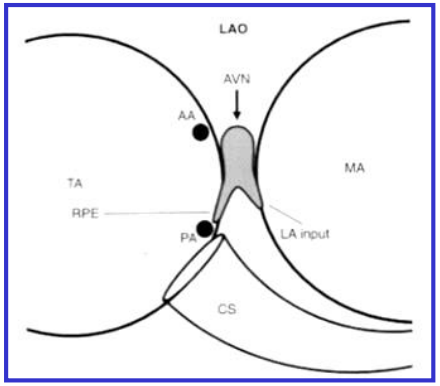




LAO







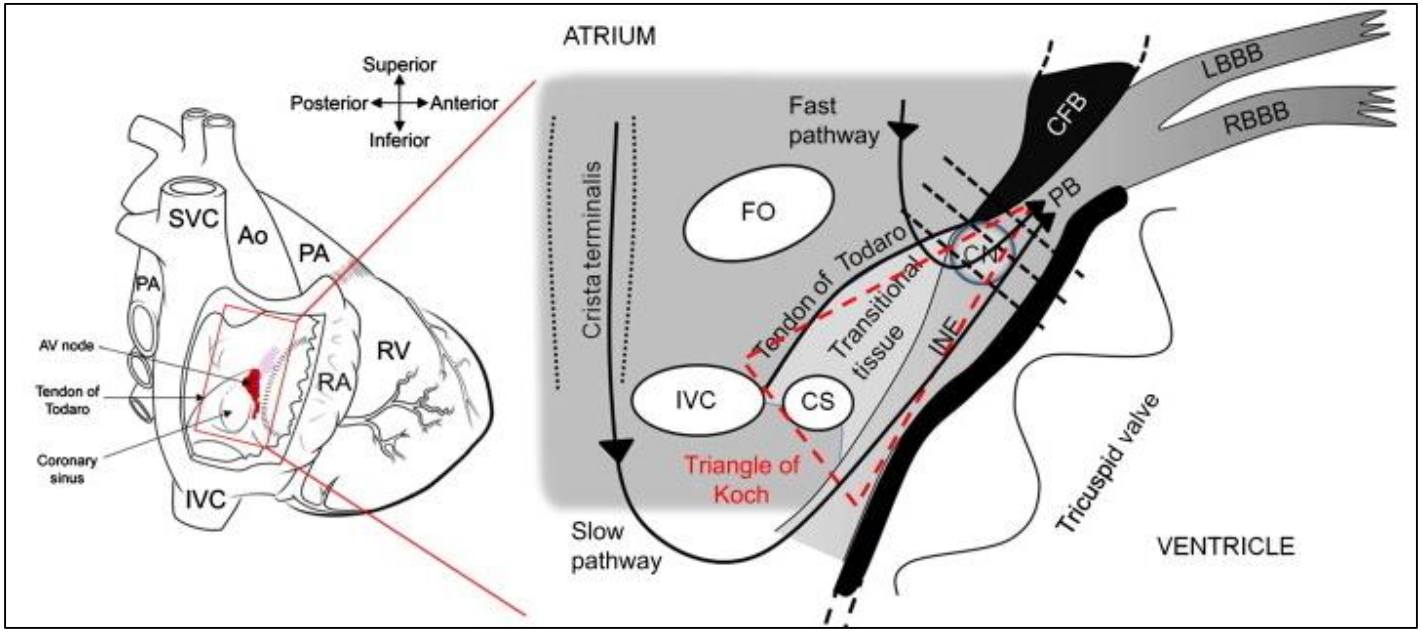
AV node – transitional zone

- ✓ **Made up of two zones, transitional and compact**
- ✓ **Transitional zone**

  - consist of "transitional cells", so called because they are inter-mediate in morphology and function between the compact nodal cell and the atrial myocytes

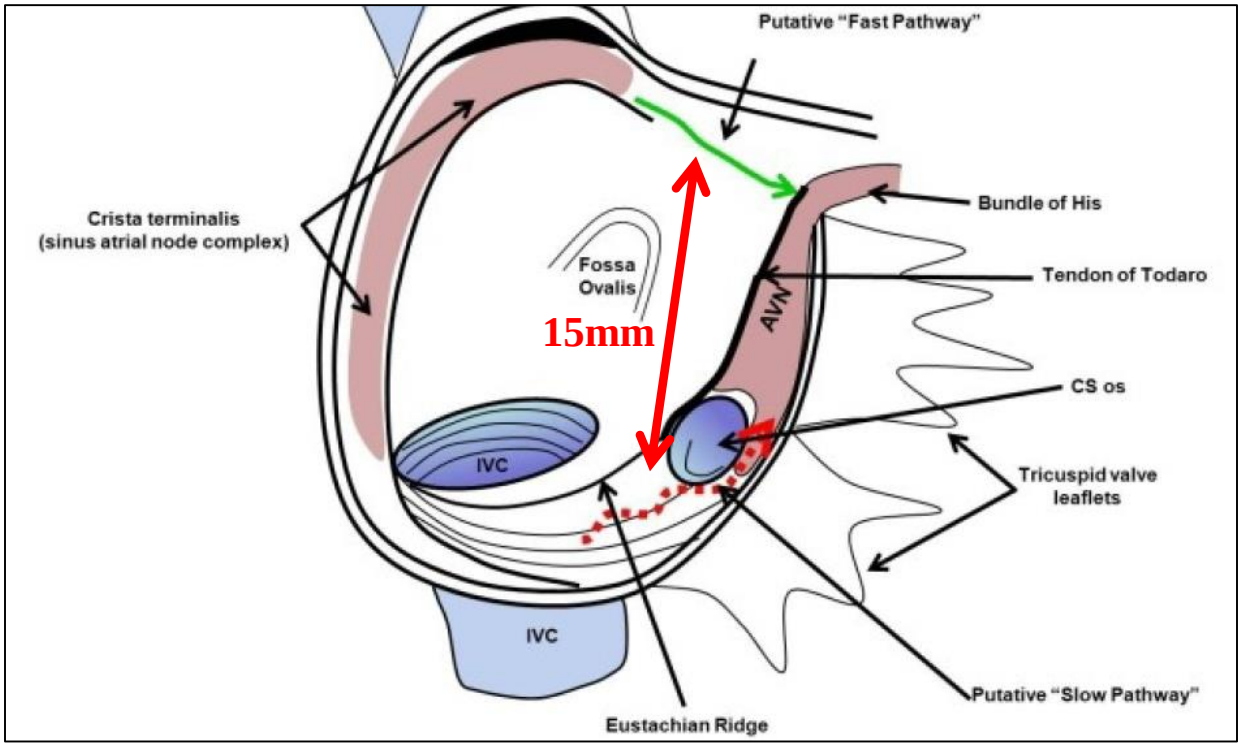
  - envelops the compact AV node

  - connection between the surrounding atrial myocardium and the compact node

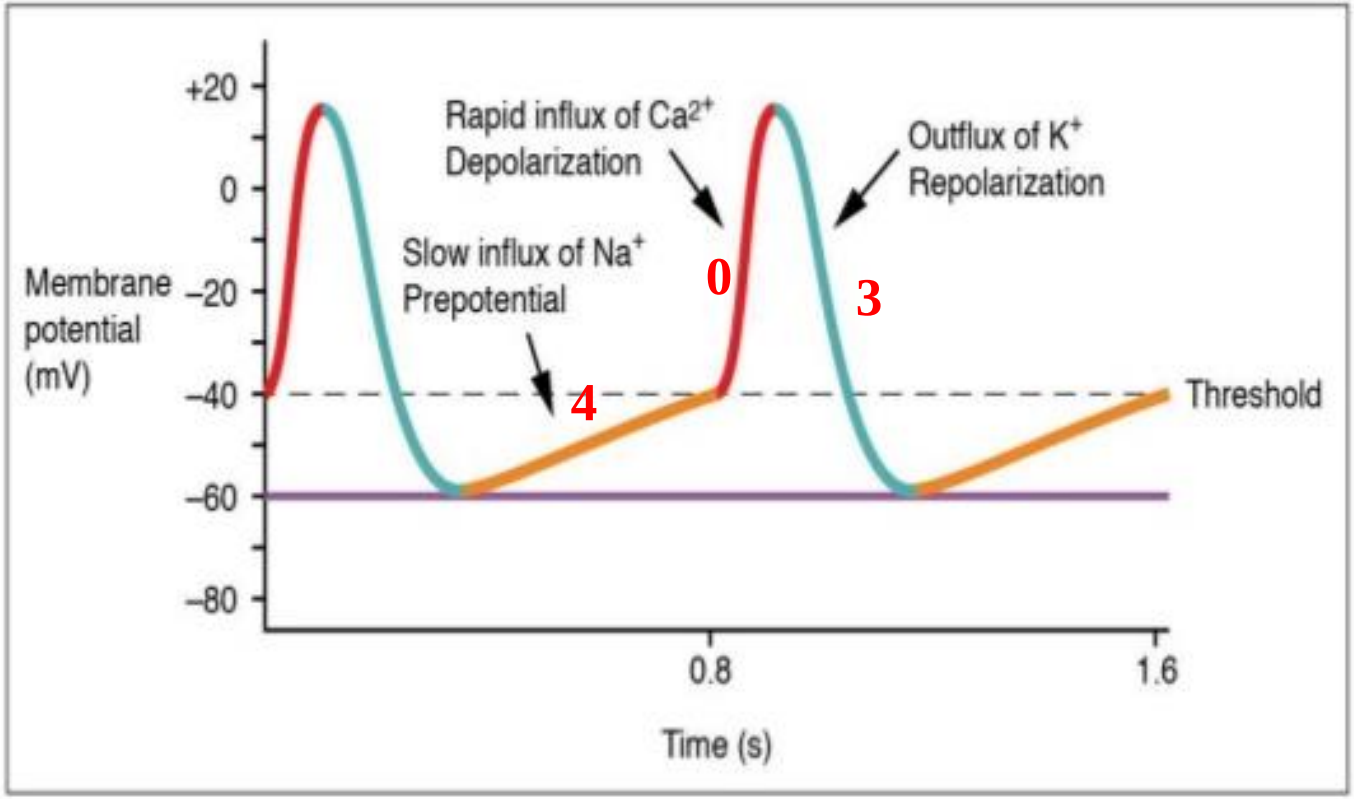


AV node – compact zone

- ✓ **Length 5-7mm, width 3-4mm**
- ✓ **3 posterior extension**
  - **putative slow pathway : direction of the CS along the TV annulus(slow conduction velocity, shorter refractory period)**
  - **putative past pathway : anterior portion of the triangle of Koch near the compact portion of the AV node**
  - **left atrial extension : direction of the mitral annulus**



Action potential in AV node



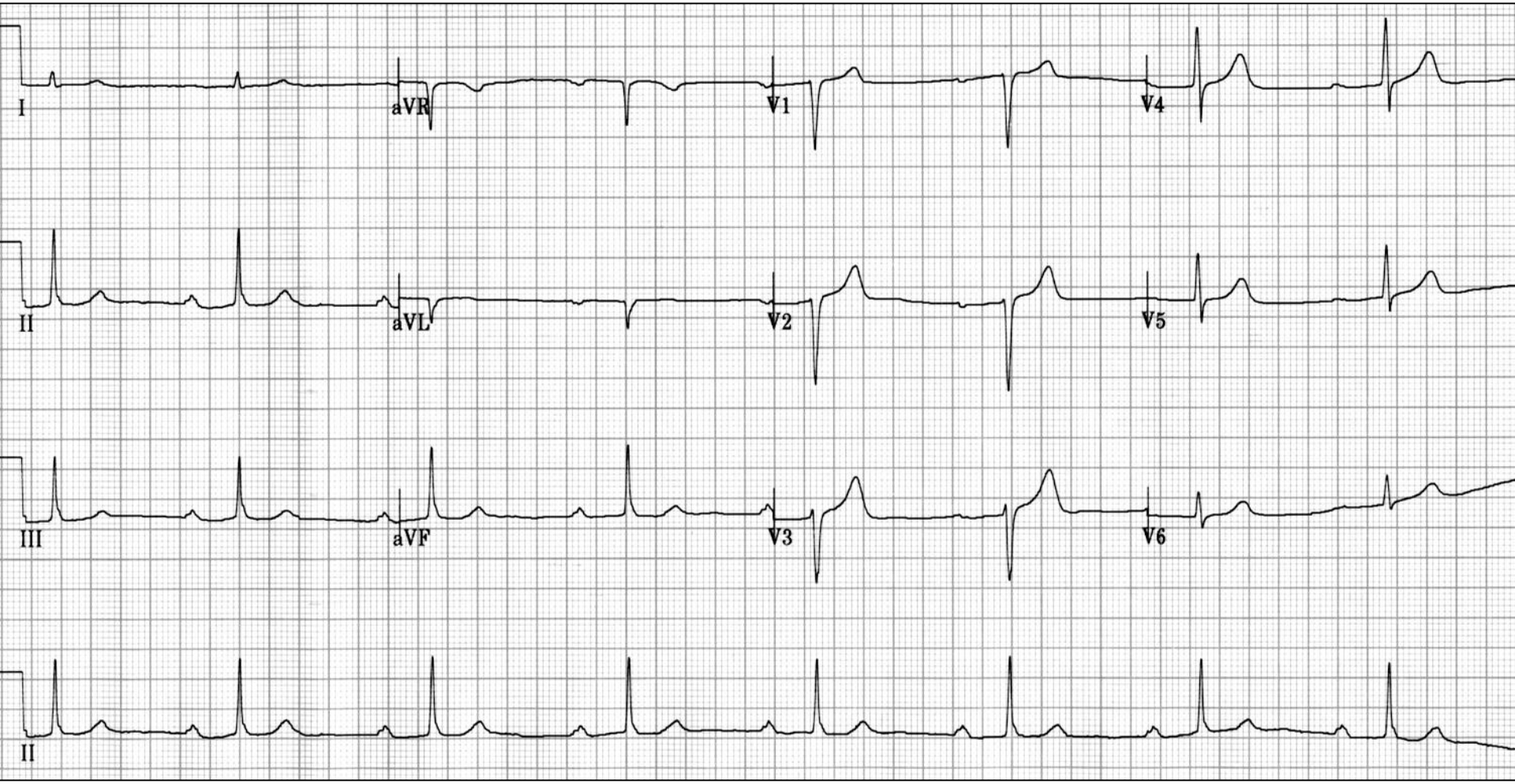
Phase 4 : slow depolarization due to Na+ and Ca2+ leak until threshold
Phase 0 : at threshold, Ca2+ channel open
Phase 3 : K+ channels open during repolarization

Role of AV node – Decremental conduction

- ✓ **Two hypothesis**
  - **decremental driving force hypothesis**
    : **action potential becomes progressively less effective as a stimulus to the unexcited portion of the fiber ahead of it.**
  - **electrotonic transmission hypothesis**
    : **"stagnation" between different zones of the AV node**
  - **recent studies assessing expression of gap junction protein (specifically connexin 43)**
- ✓ **Allowing the ventricles to stay in diastole, providing sufficient ventricular filling time**
- ✓ **Protection of the ventricles from rapid rates during atrial tachycaridas**

 # Decremental conduction(감쇠전도) : 신호가 축색 또는 전선을 따라 전도되면서 점점 크기가 작아지는 것

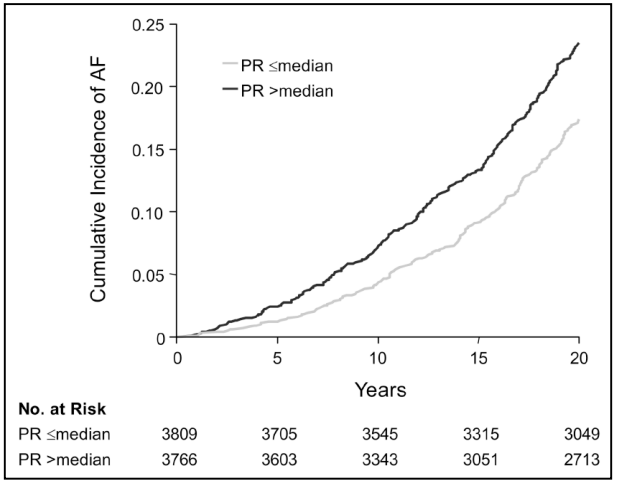
First-degree AV block



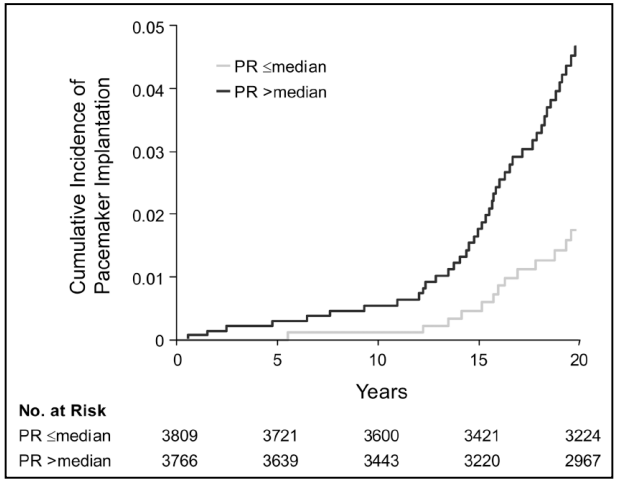
- ✓ **PR interval exceeds 200 ms**
- ✓ **PR prolongation = AV node (AH interval) + His-Purkinje system(H-V interval)**

JAMA. 2009 June 24; 301(24): 2571–2577. doi:10.1001/jama.2009.888.

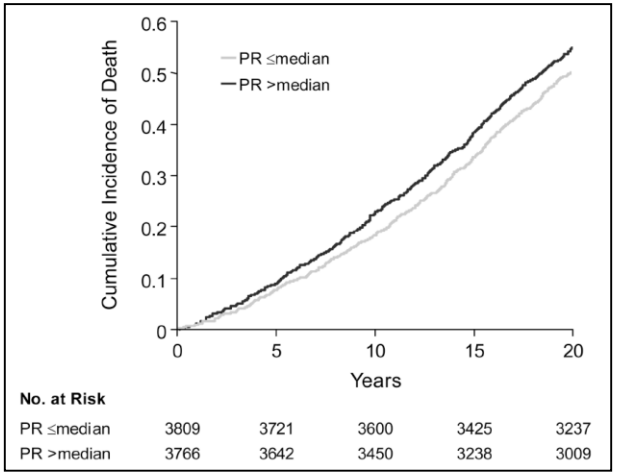
Long-term Outcomes in Individuals with a Prolonged PR Interval or First-Degree Atrioventricular Block



2-fold



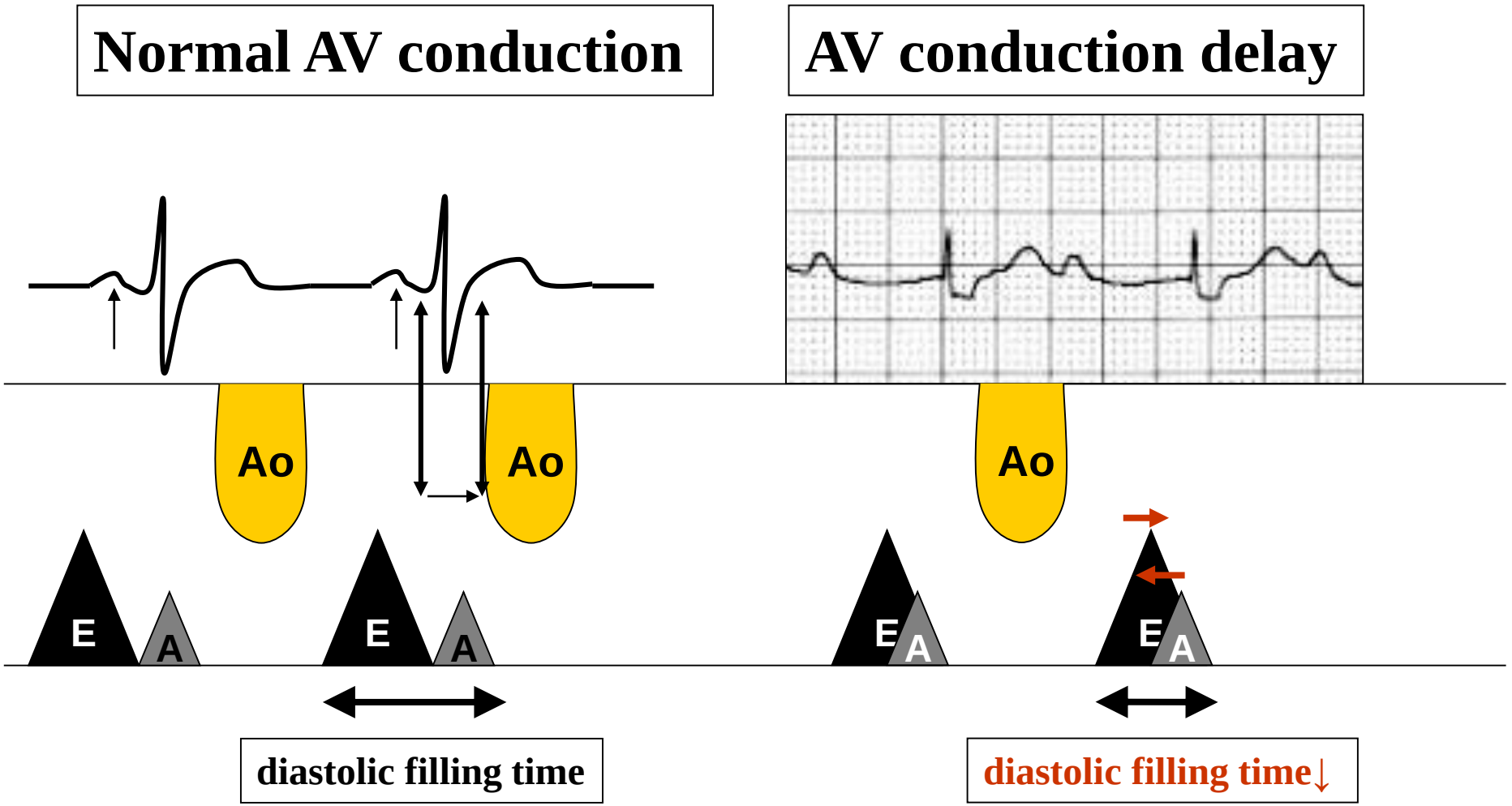
3-fold



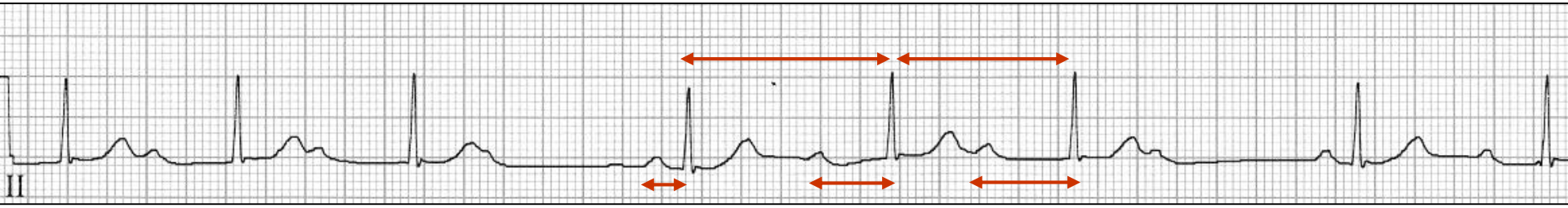
1.4-fold

Conclusion—PR prolongation is associated with increased risks of AF, pacemaker implantation, and death.

First-degree AV block



Second-degree AV block – type I (Wenckebach)

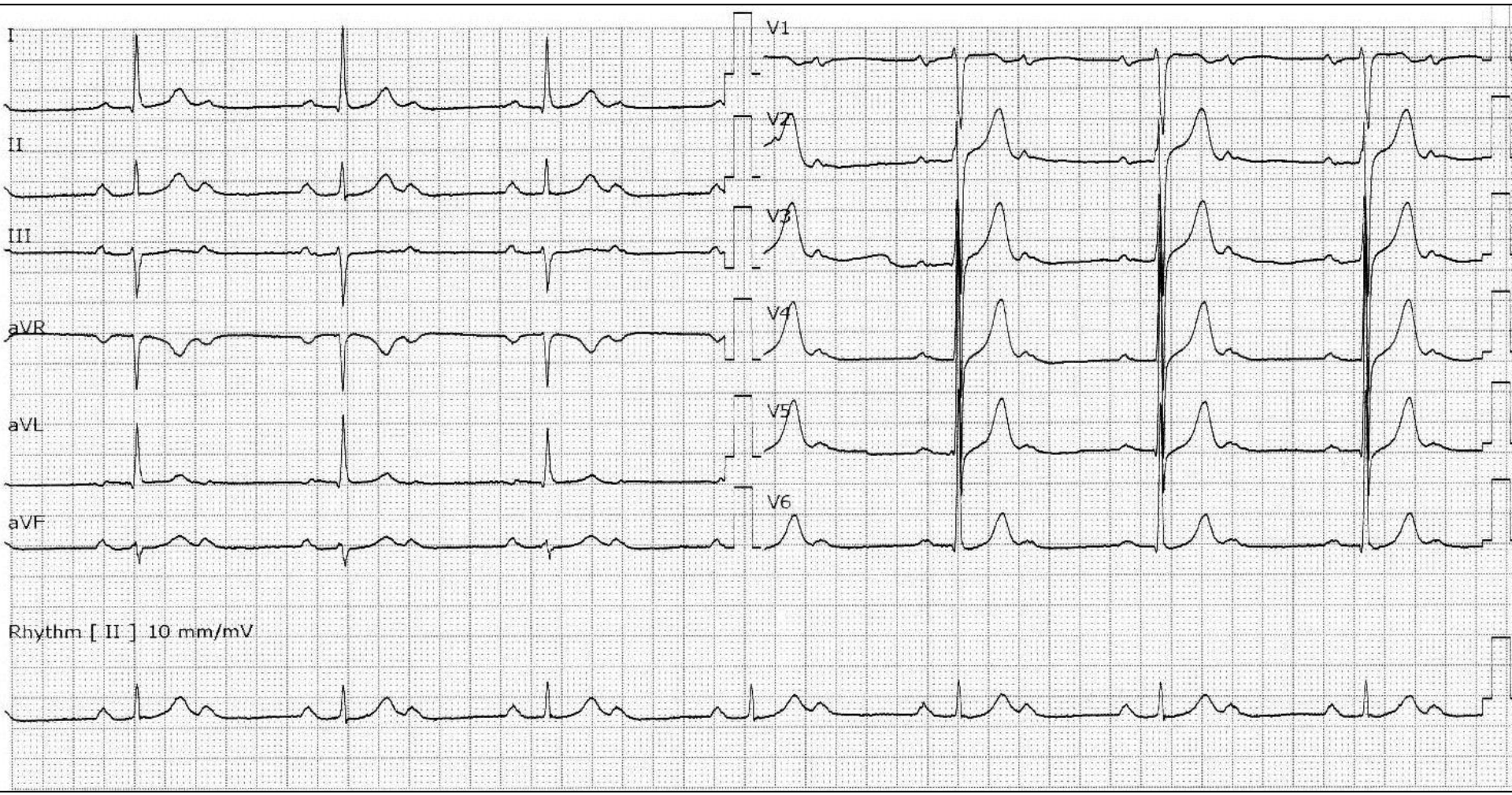


- ✓ **Interval between successive beats progressively decreases, although the conduction time increases**
- ✓ **Duration of the pause produced by the nonconducted impulse is less than twice the interval preceding the blocked impulse**
- ✓ **Cycle following the nonconducted beat is longer than the cycle preceding the blocked impulse**
- ✓ **More benign and does not progress to more advanced forms of AV conduction disturbance.**
- ✓ **Block level : usually AVN or proximal to the His bundle**

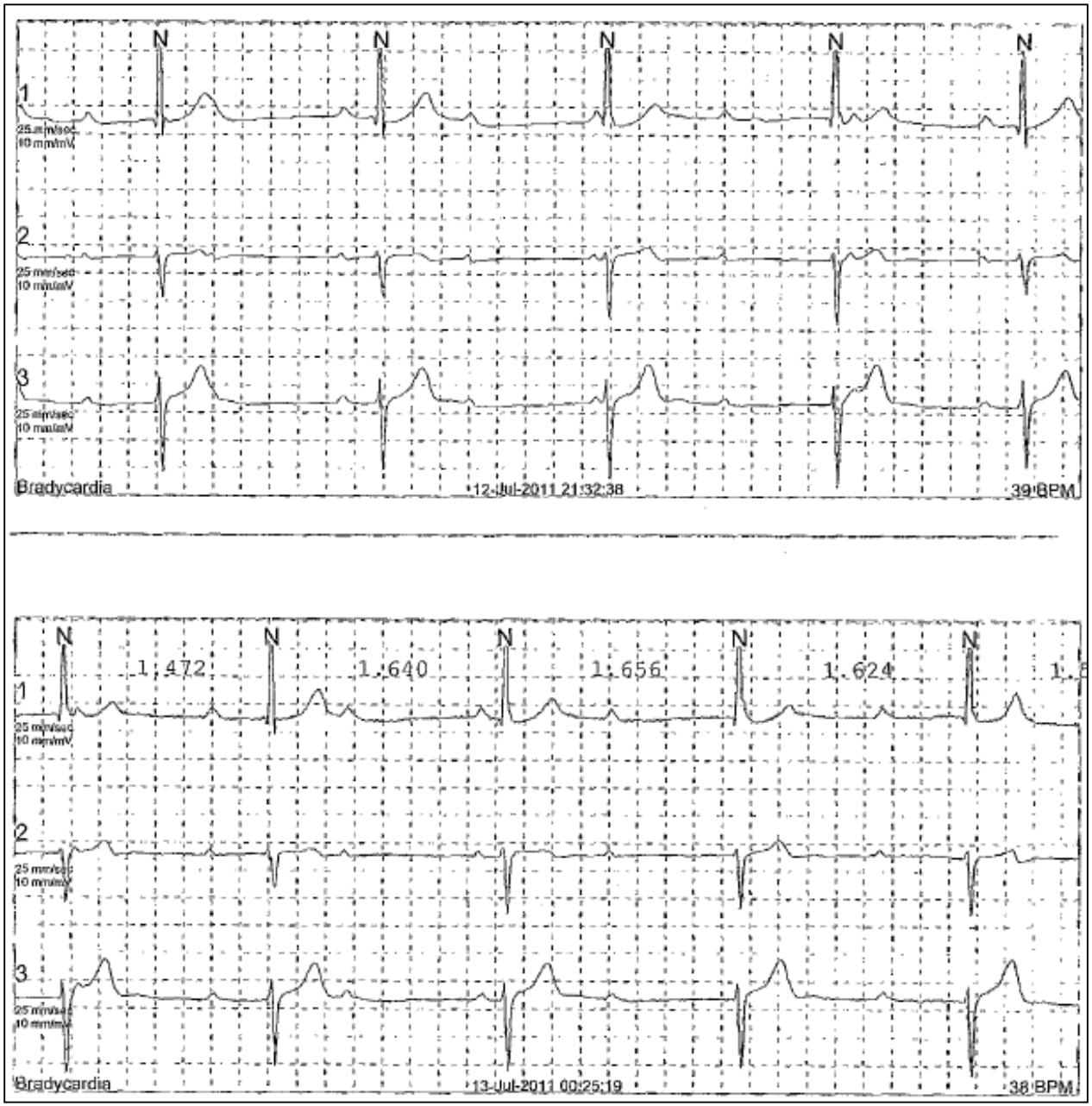
Second-degree AV block – type II

- ✓ **PR interval remains constant prior to the blocked P wave.**
- ✓ **Often antedates the development of complete AV block**
- ✓ **Block level : His-Purkinje system, particularly association with a BBB**

2 : 1 AV block

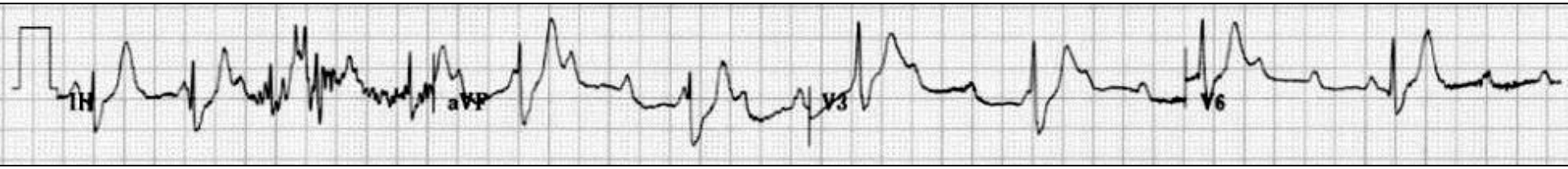


2 : 1 AV block – CAVB in Holter



2 : 1 AV block

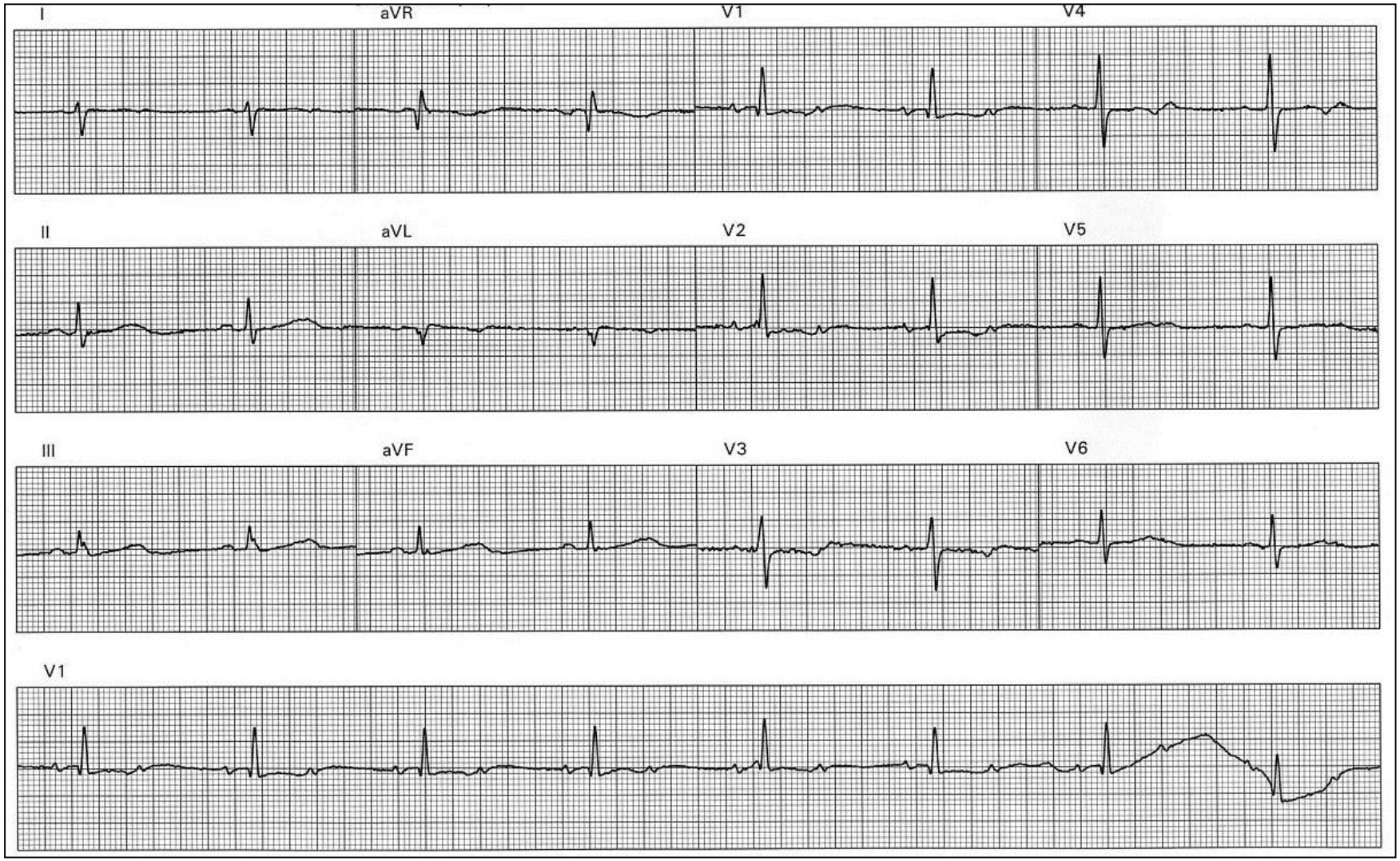
Exercise

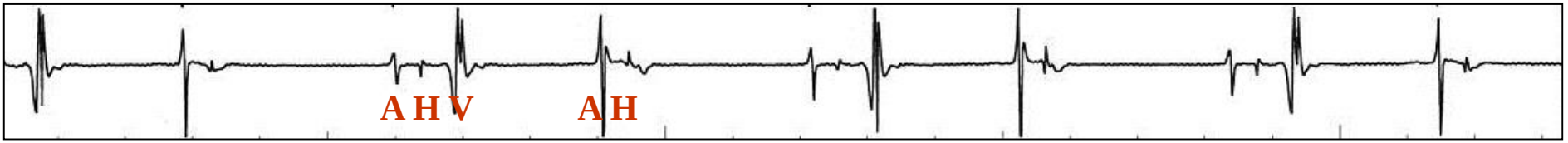


Worsen AV conduction

2 : 1 AV block – AH block in EP test

2 : 1 AV block – HV block



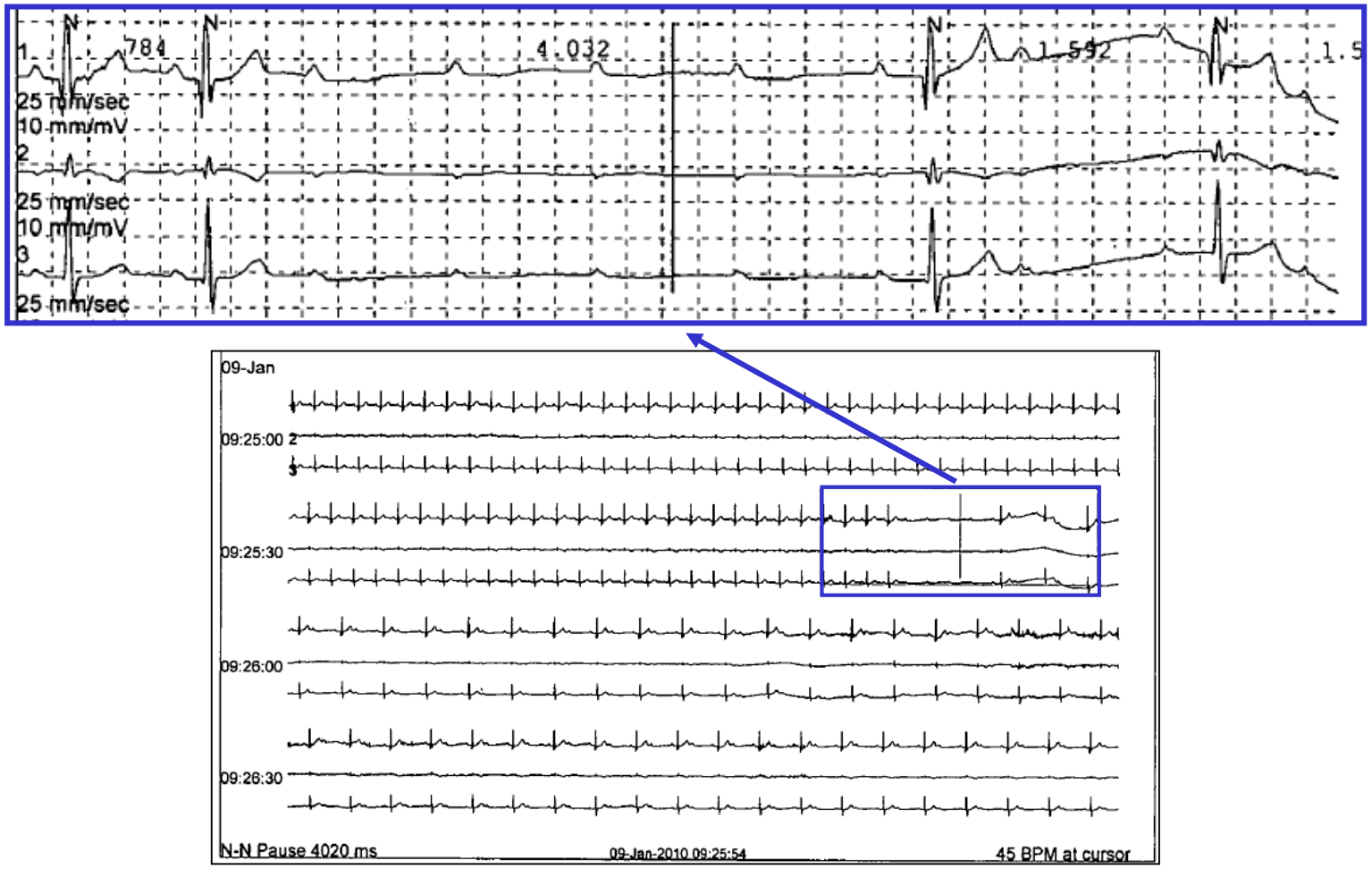


His bundle electrogram

Noninvasive DDx of the block level

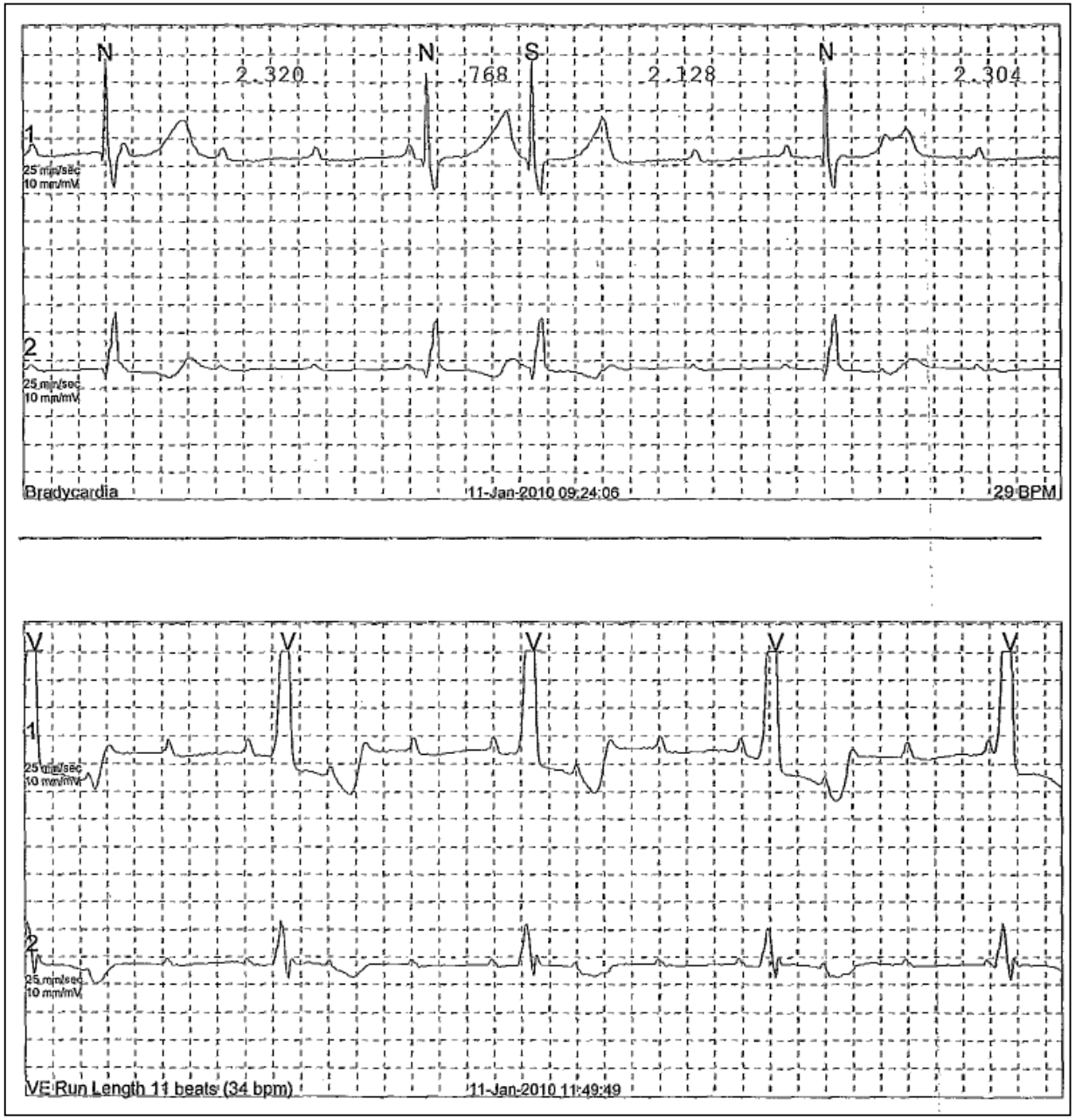
	AV nodal	Infranodal
Exercise/Isoproterenol	Improves	Conduction ratio may worsen
Atropine	Improves	Conduction ratio may worsen
Vagal maneuvers	Worsens	No changes
Beta blocker	Worsens	No changes

High-degree AV block



- ✓ **PR interval remains constant and P-P cycle is regular until two or more dropped P waves in a row occur producing long ventricular pauses.**
- ✓ **QRS resembles that of the regular cardiac rhythm**

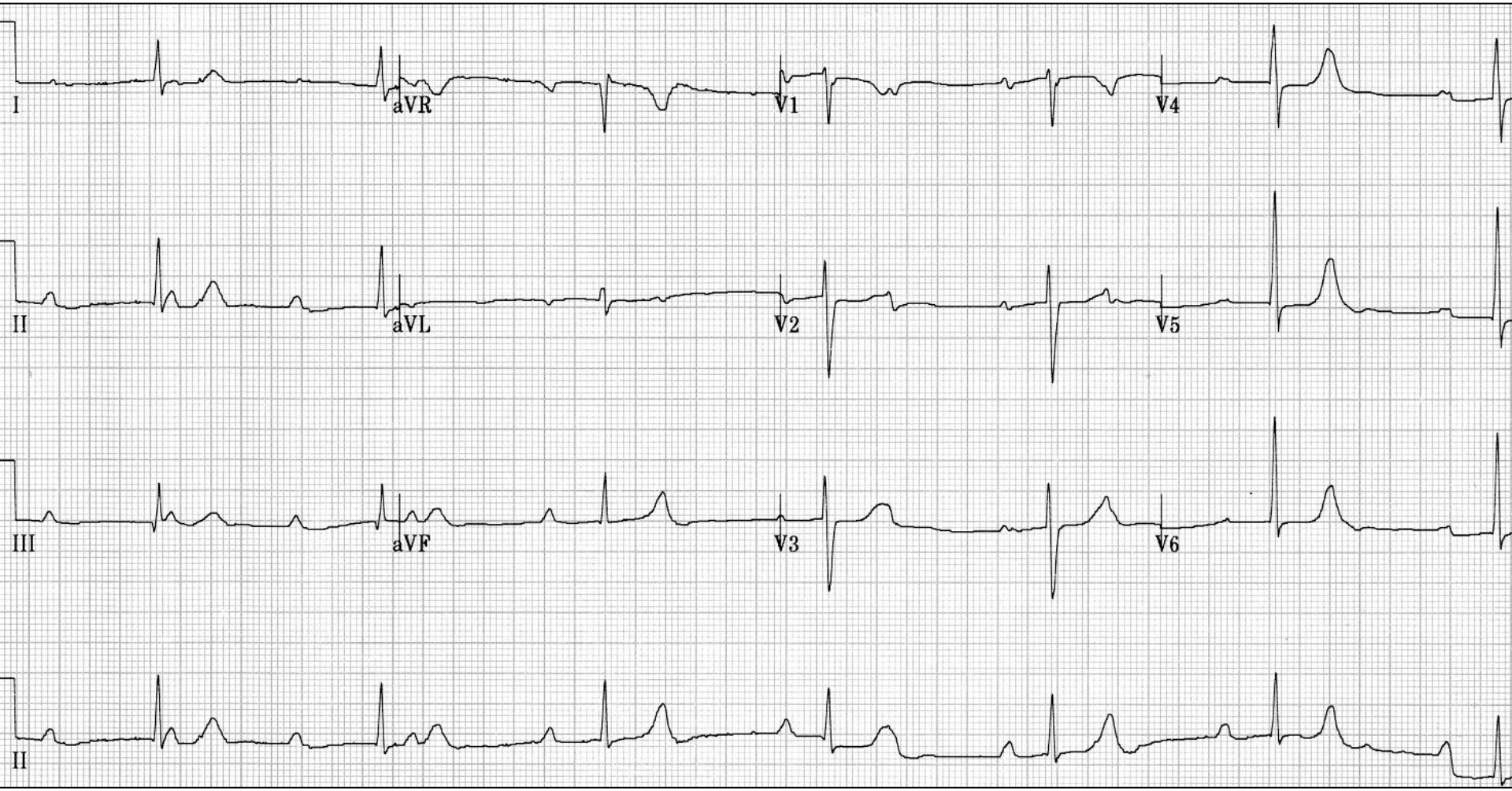
High-degree AV block



High-degree AVB

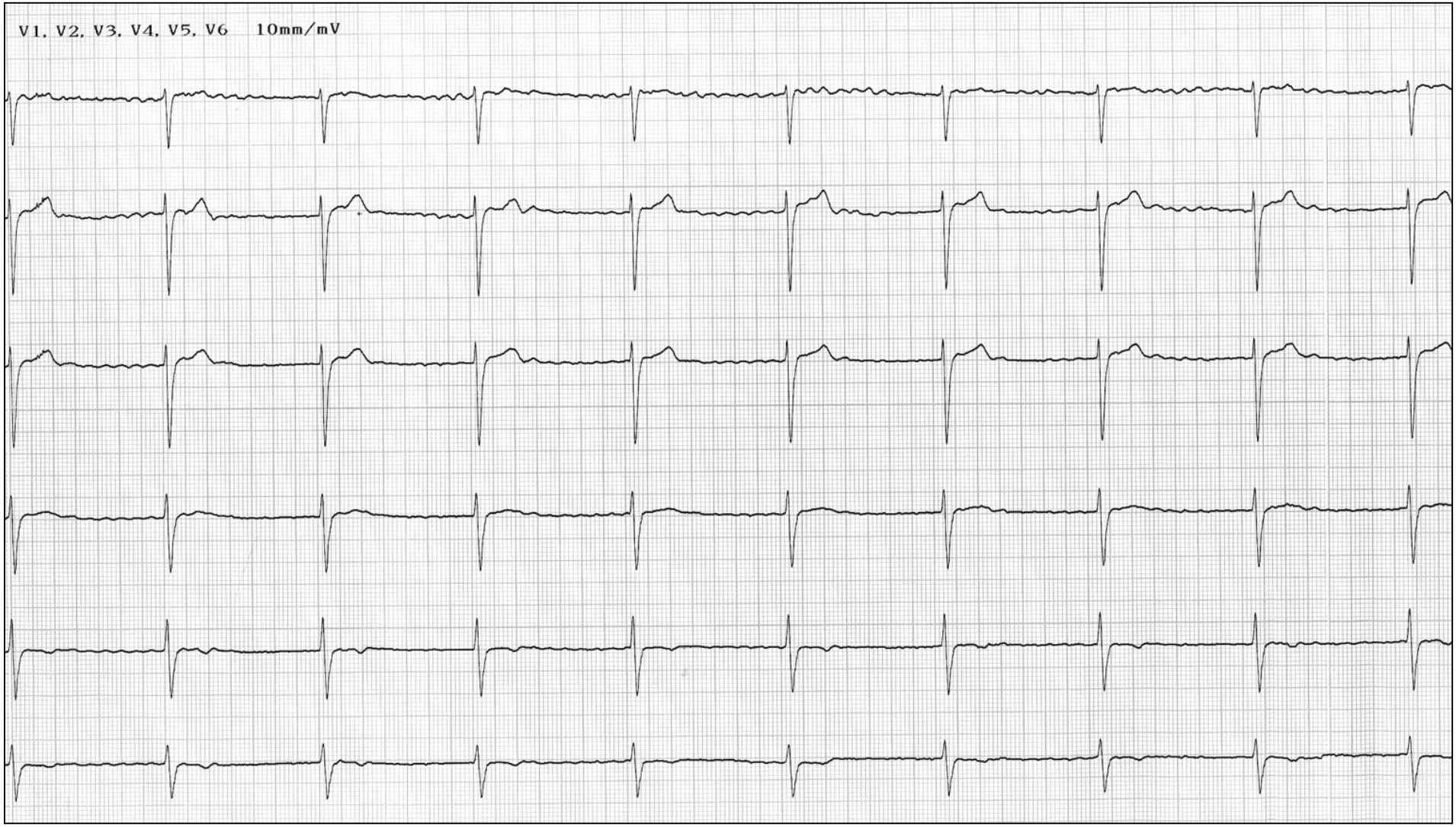
Complete AVB

Third-degree AV block



- ✓ **The atrial activity is not conducted to the ventricle.**
- ✓ **The atria and ventricles are controlled by independent pacemakers.**
- ✓ **One type of complete AV dissociation**

Third-degree AV block in AF



AV dissociation

1. Definition :

- dissociated or independent beating of the atria and ventricles

2. Classification

- Slowing of the dominant pacemaker (usually the SN), which allows escape of a subsidiary or latent pacemaker. (Isorrhythmic AV dissociation)

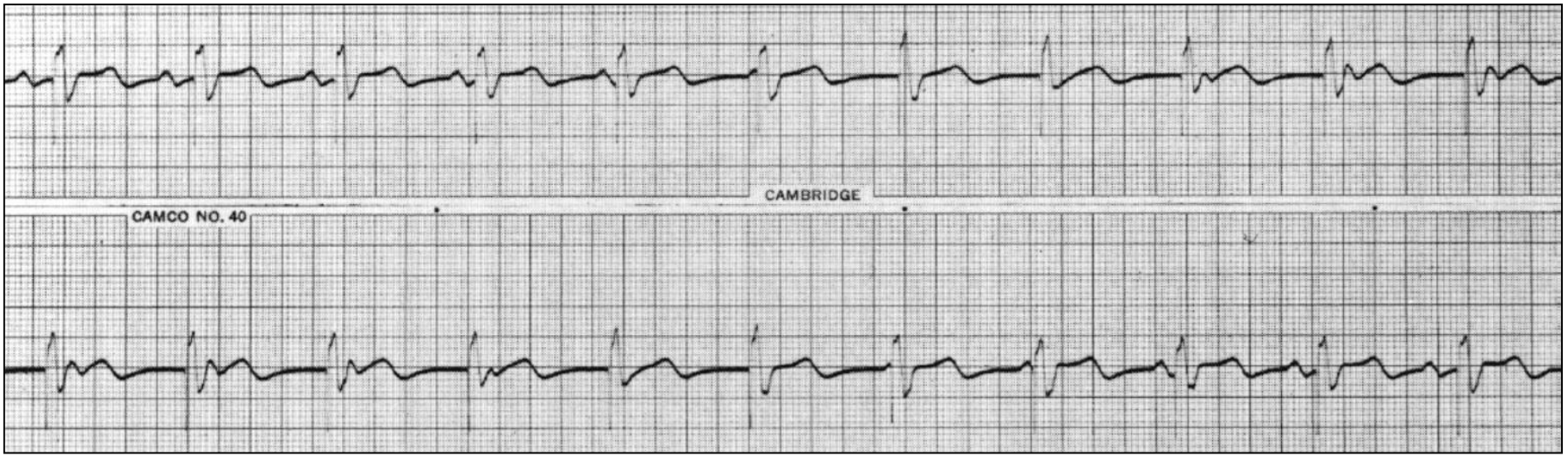
- Acceleration of the latent pacemaker, which usurps control of the ventricles. (Interference AV dissociation)

- Block, generally at the AV junction, which prevents impulses formed at a normal rate in a dominant pacemaker from reaching the ventricles (Complete AV dissociation)

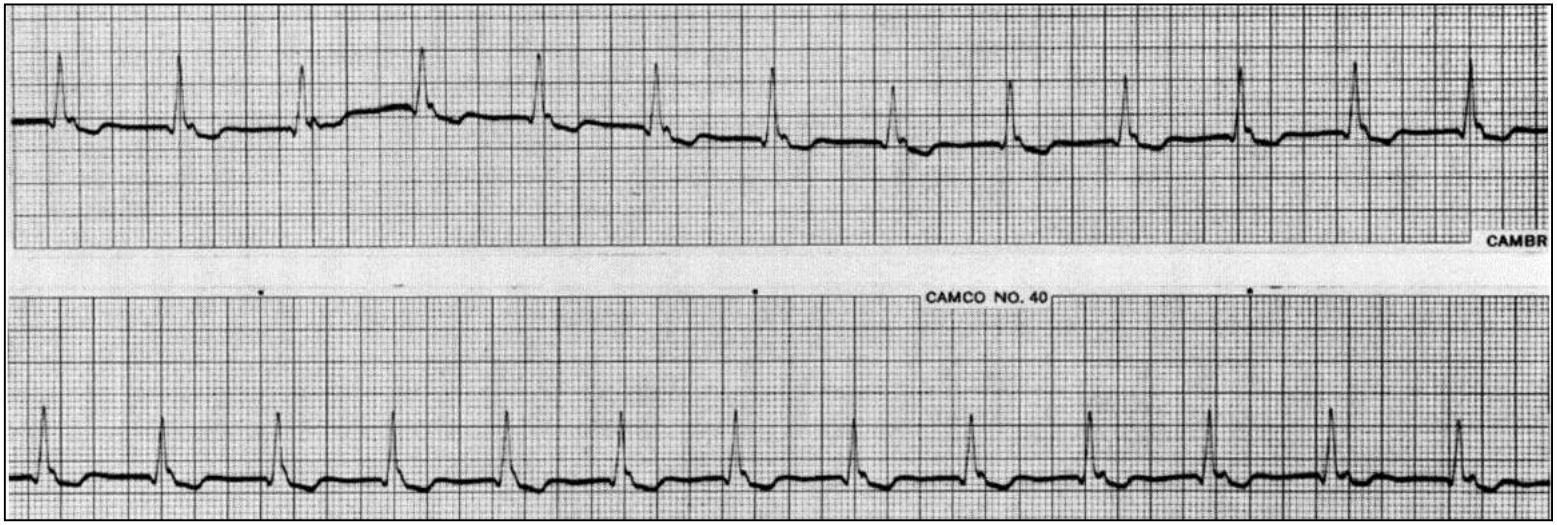
- Combination causes

AV dissociation - Isorrhythmic

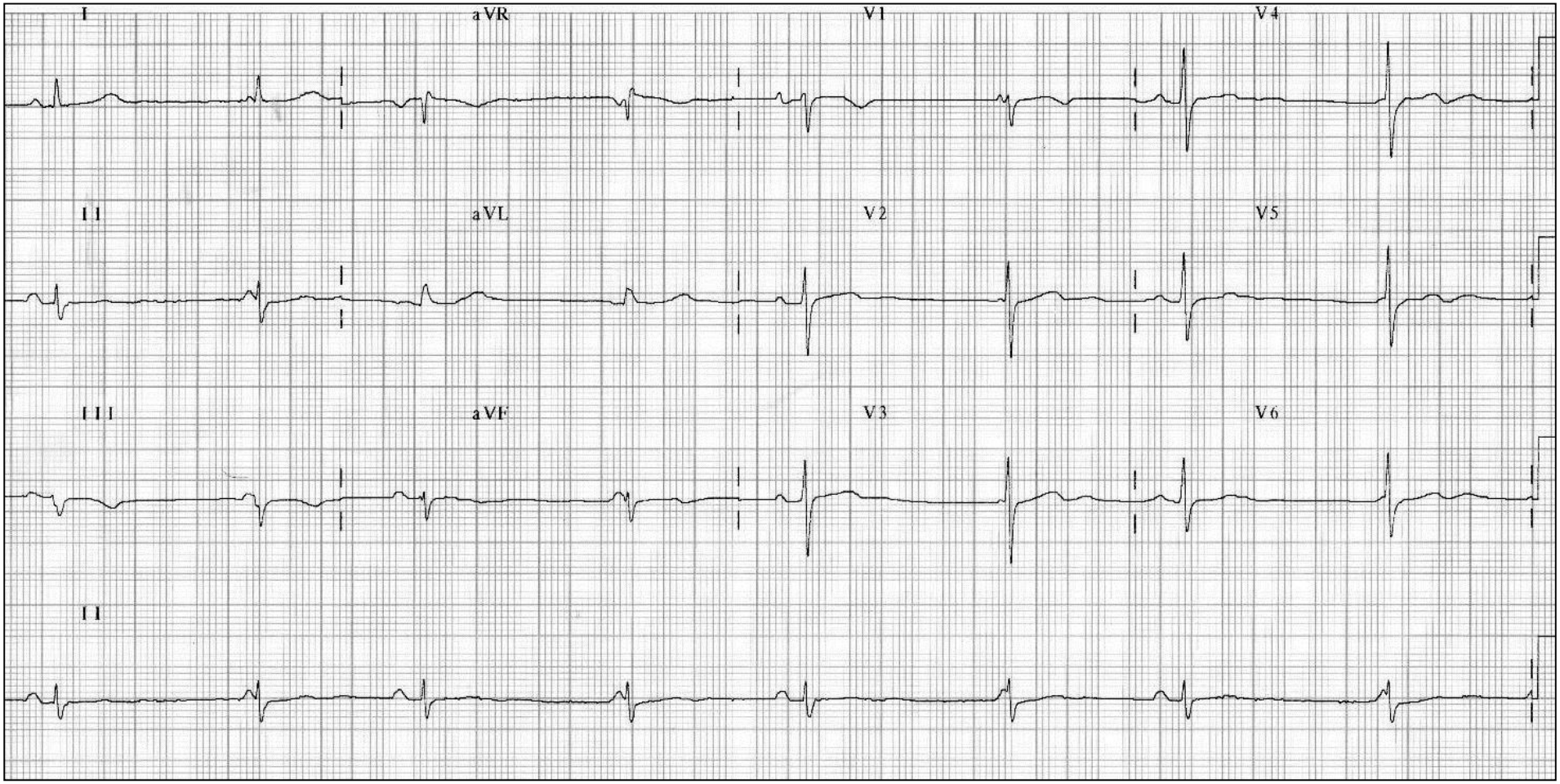
Pattern I : Rhythmic variation in PR and RP interval



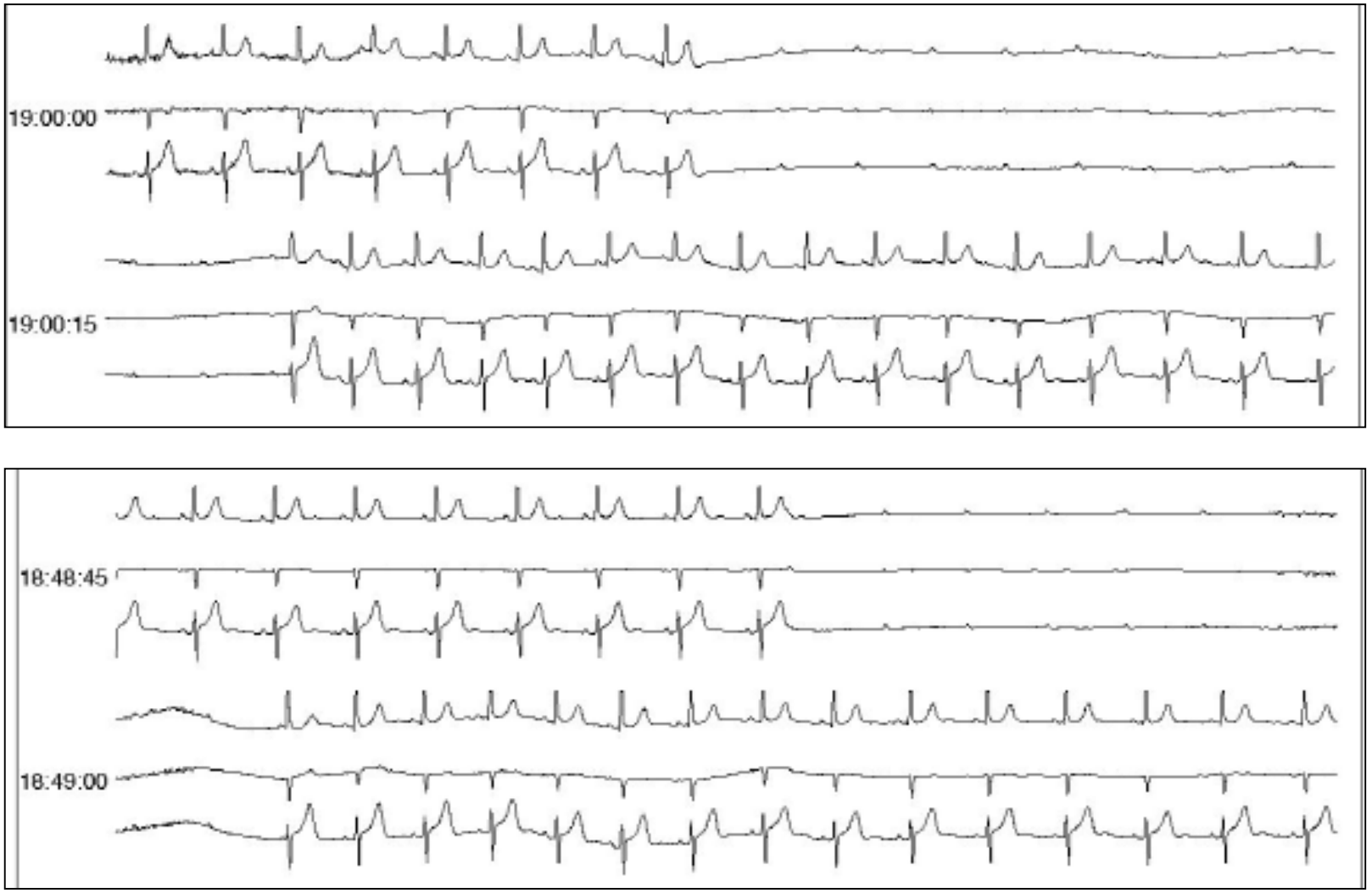
Pattern II : Relatively fixed relationship between P and QRS



AV dissociation – Isorrhythmic – pattern I

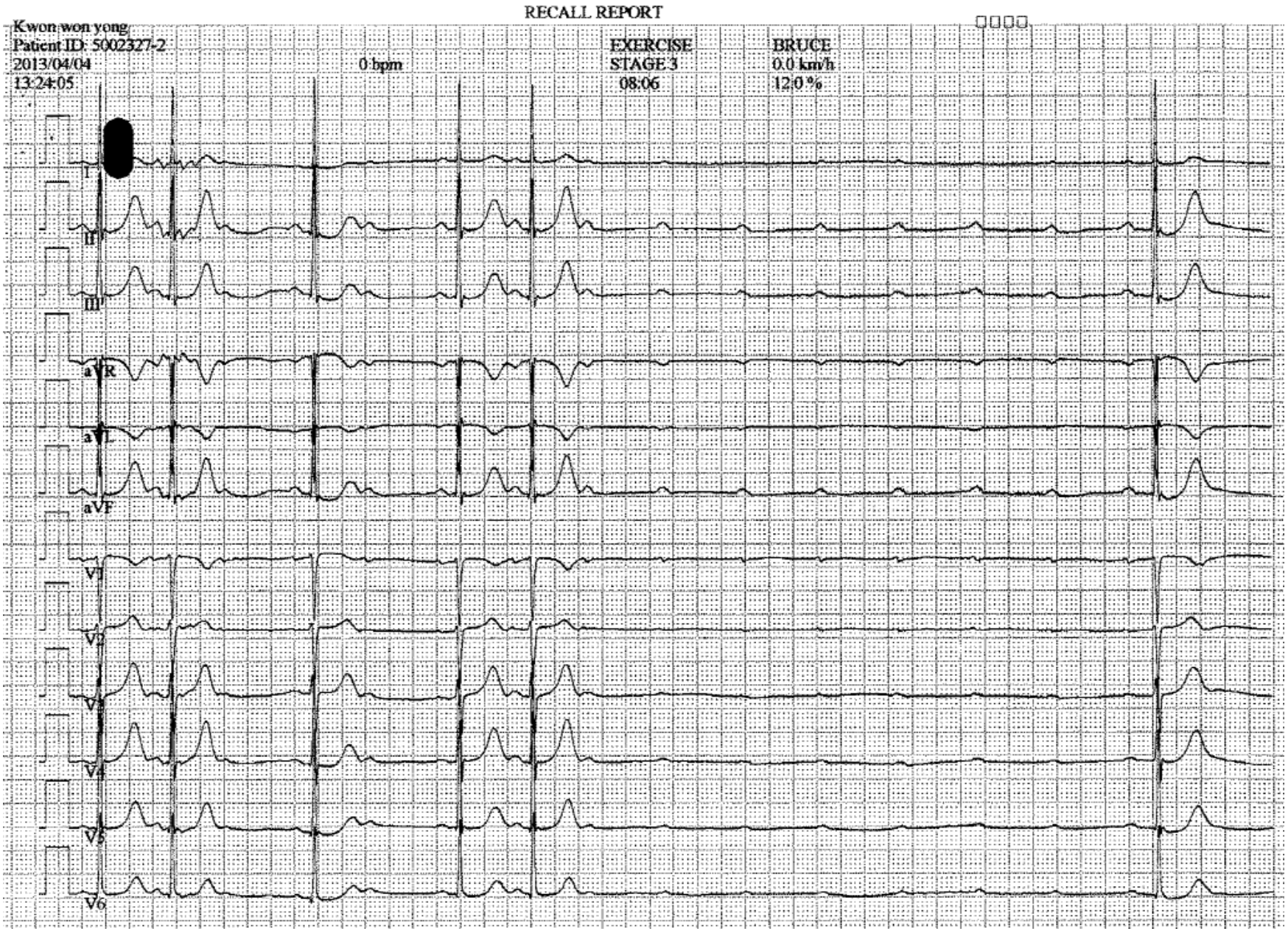


Paroxysmal AV block – Holter monitoring



One-to-one AV conduction suddenly changes to complete AV bock

Paroxysmal AV block – TM test



Paroxysmal AV block – AP 500 ms

Paroxysmal AV block

- ✓ **Paroxysmal complete AV block**
  - **one-to-one AV conduction suddenly changes to compete AV block**
  - **phase 4 block**
- ✓ **Characteristics**
  - **recurrent syncope due to idiopathic AV block with long pause**
  - **absence of cardiac and ECG abnormalities**
  - **absence of progression to persistent forms of AV block**
  - **efficacy of cardiac pacing therapy**
- ✓ **Two types of PAVB**
  - **intrinsic AV block ; never initiated by atrial, His, or ventricular extrasystole, increased HR(tachycardia dependent AV block), or decreased HR(bradycardia dependent AB block).**
  - **extrinsic vagal AV block**

Paroxysmal AV block

- ✓ **Occur following**
  - **APCs, conducted or nonconducted**
  - **retrogradely conducted VPCs**
  - **His bundle extrasystoles retrogradely conducted to the atrium but with block to the ventricle during carotid sinus massage or**
  - **during a Valsalva maneuver**
- ✓ **Dangerous, because of the unreliable escape mechanism.**
- ✓ **Diagnosis is often missed because of its paroxysmal character.**
- ✓ **Management : pacemaker implantation**