

Electrophysiology study (EPS) and ablation therapy

Andrew Ying-Siu Lee, MD, PhD.

- **Invasive procedure utilizing intracardiac multipolar electrode catheters to evaluate cardiac conduction system (functions of sinus node, atrioventricular node and His-Purkinje system), and to determine inducible supraventricular or ventricular arrhythmias for ablation therapy (ablate myocardium involved in the arrhythmias to prevent further episodes).**

Indications of EPS

- **Class I indications (definitely needed, appropriate):**
 - symptomatic patients with heart block not apparent on electrocardiogram
 - patients with narrow QRS tachycardia not tolerating or responding to medications, or preferring ablation therapy
 - patients with sustained wide QRS tachycardia
 - symptomatic patients with accessory pathway tachycardia
 - unexplained syncope, palpitations

■ **Class II indications (possibly needed, equivocal):**

- symptomatic patients with heart block in order to direct therapy and evaluate prognosis
- high risk patients with WPW syndrome or arrhythmias

■ **Class III indications (not needed, inappropriate):**

- patients with sinus node dysfunction, arrhythmias, syncope with identifiable cause or mechanism

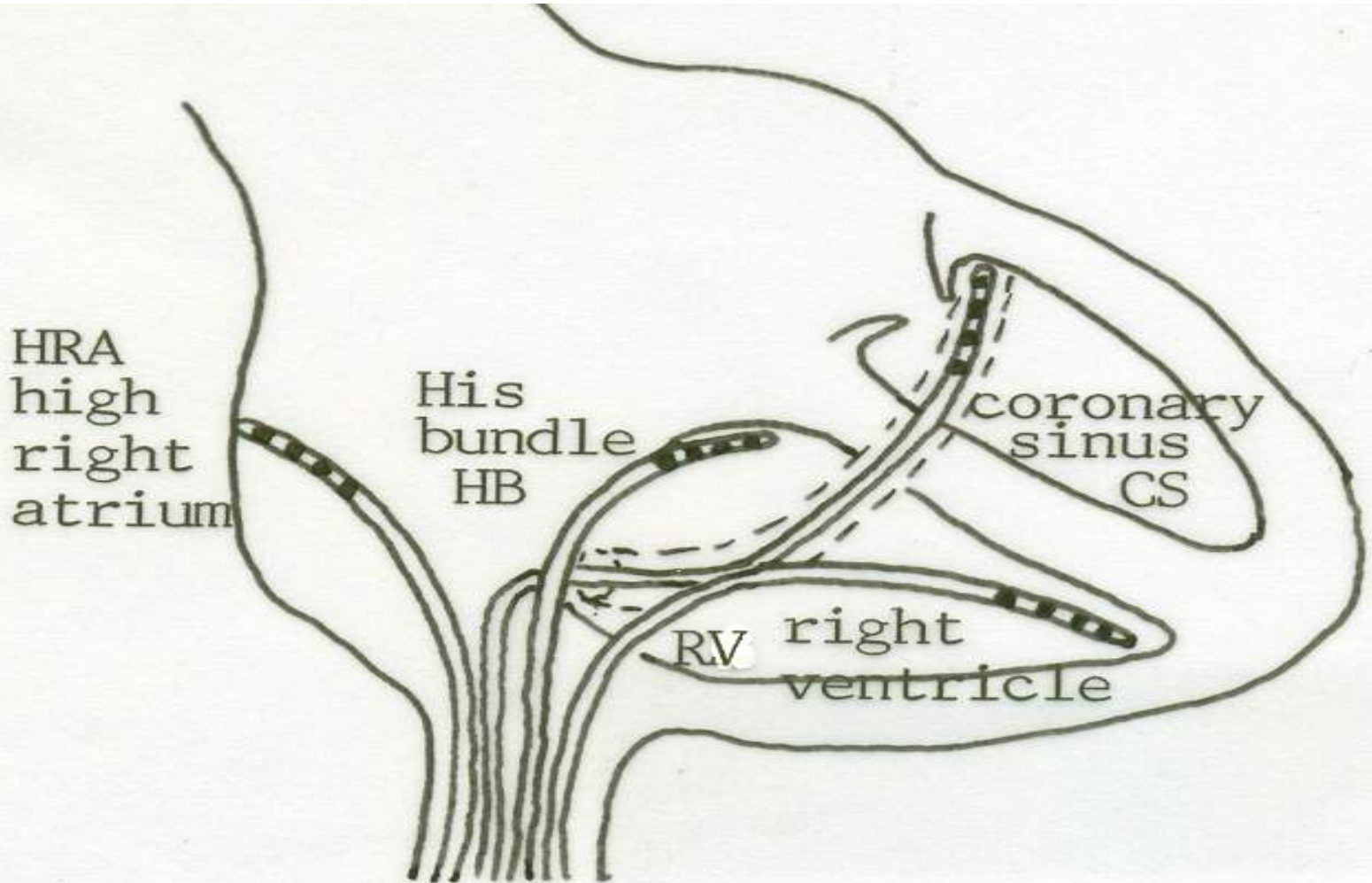
■ **Risks and complications of EPS:-**

hypotension, hematoma, hemorrhage, vascular injury, thrombophlebitis, systemic emboli, cardiac tamponade, pneumothorax, death

■ **Contraindications to EPS:-**

bleeding disorder, unstable angina, uncontrolled heart failure, severe peripheral vascular disease, valvular stenosis (left ventricular access), thrombophlebitis (femoral access), groin infection, uncooperative patient

Catheter insertion sites



coronary sinus: for recording left atrial and ventricular electrograms (because it lies in atrioventricular groove between left atrium and ventricle)

Basic electrophysiology study

- Measuring baseline conduction intervals and evaluating patients's response to programmed electrical stimulation
- Typical baseline EPS recording:

(1)intracardiac recording of sinus conduction:

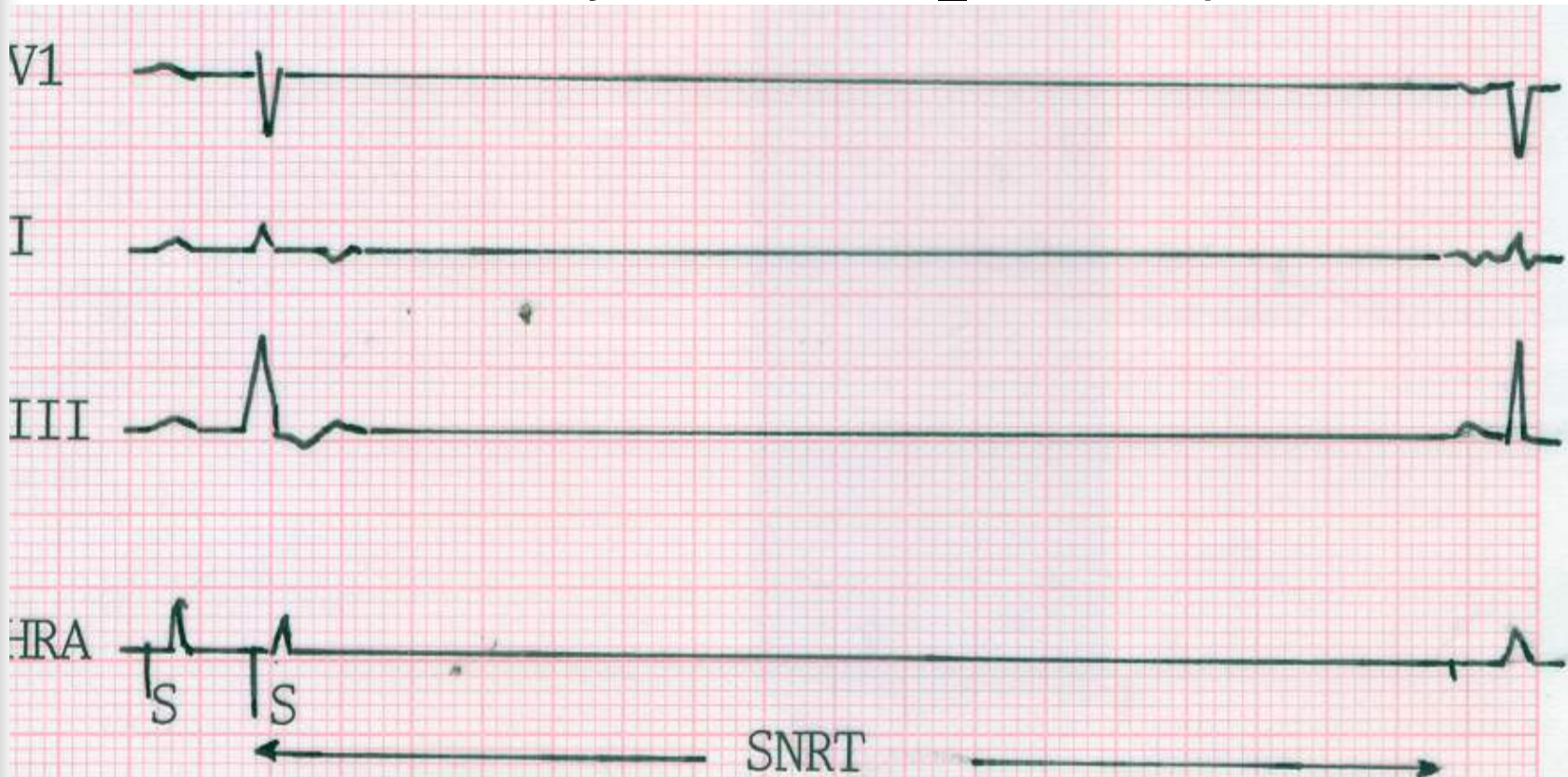


(2) Programmed stimulation protocols:

- = delivery of stimuli to atrium or ventricle to evaluate conduction system**
- assess cardiac refractory periods (atria, AV node and ventricle), conduction properties, automaticity, presence and characteristics of reentrant circuits**

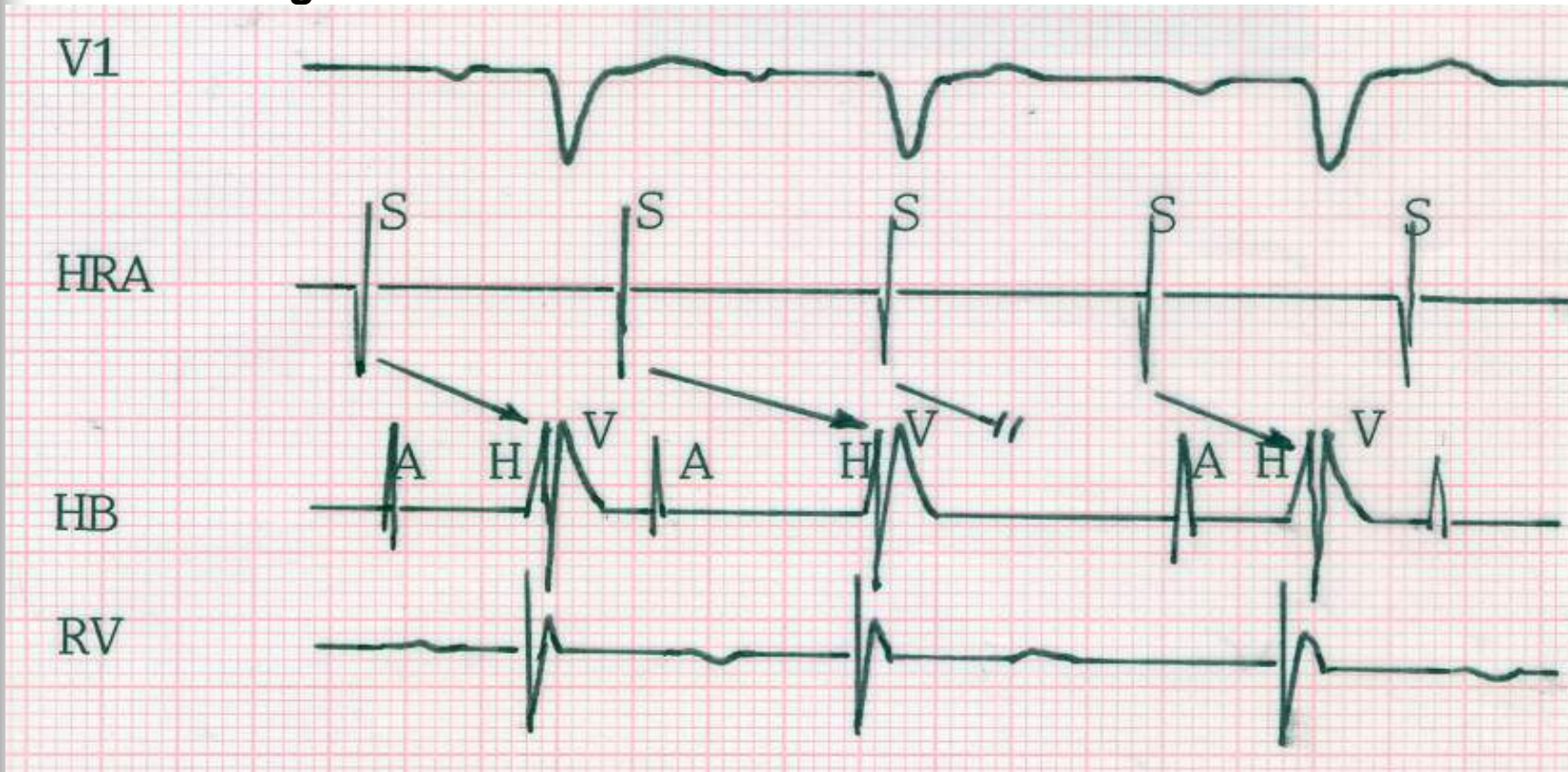
Sinus node function

- Measurement of sinus node recovery time (SNRT) = time from last paced beat to the first spontaneous atrial beat, after pacing and abruptly terminating pacing the right atrium (normal = 1.5 seconds or less) and the corrected sinus node recovery time (=baseline sinus cycle length – sinus node recovery time, normal ≤ 550 msec).



Atrioventricular conduction

- Measurement of AV node function = AH interval, AV block (Wenckebach block) cycle length and AV node effective refractory period (=longest atrial coupling interval A1-A2 that blocks in AV node). Atrial overdrive pacing → progressive PR and AH prolongation just prior to the blocked beat (Wenckebach block) and shortening of AH interval after the blocked beat.



- Measurement of His-Purkinje conduction:
normal HV interval = 35 – 558 ms

Paroxysmal supraventricular tachycardia

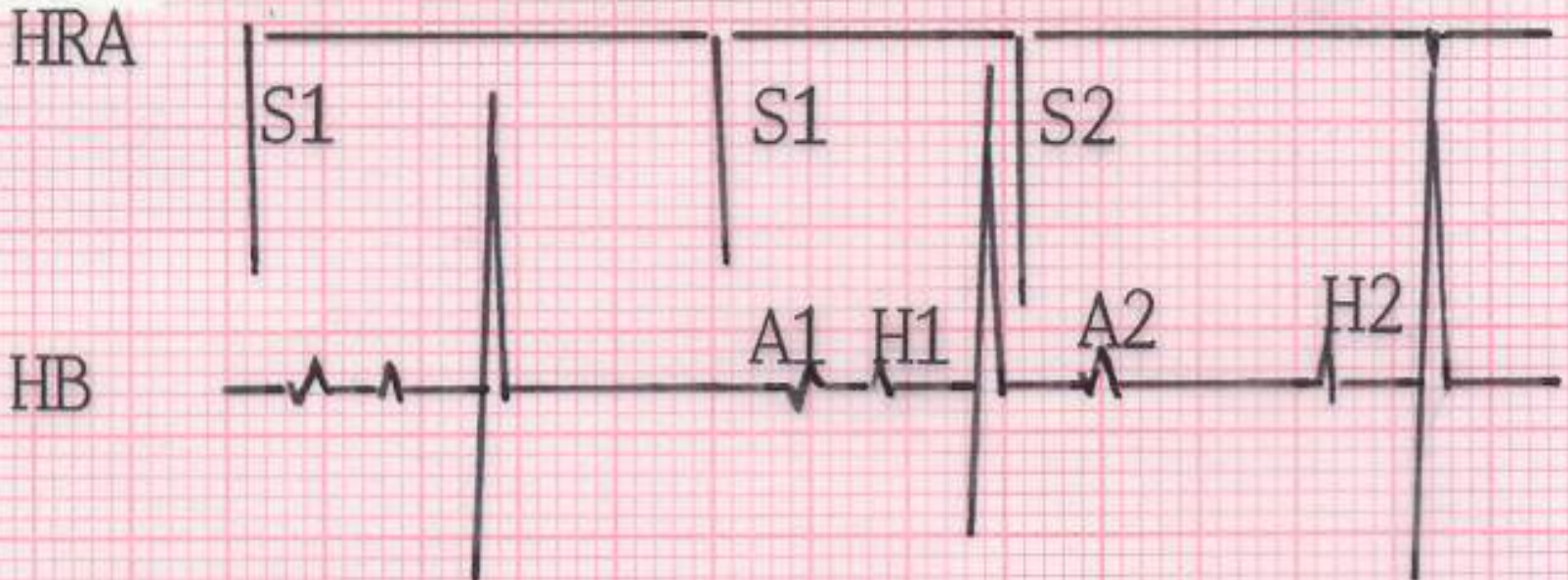
3 major types: atrioventricular node reentrant tachycardia

AV reentrant tachycardia (AVRT)

atrial tachycardia)

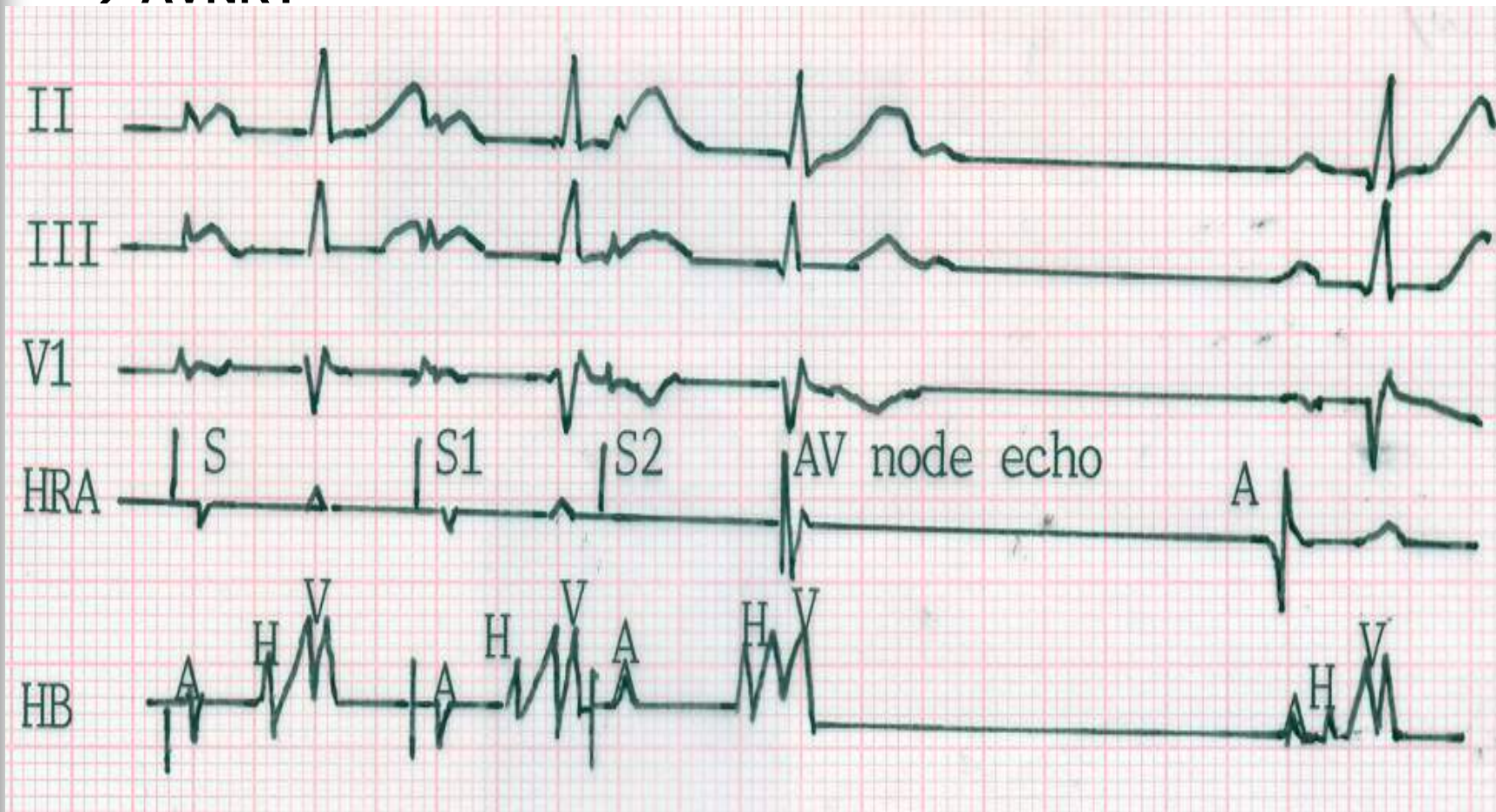
(1) Atrioventricular node reentrant tachycardia (AVNRT) :

- most common
- reentrant circuit at AV node with 2 AV nodal pathways
- atrial extrastimulus → increase AH interval (=“AV nodal jump”) , indicating presence of dual AV nodal pathways

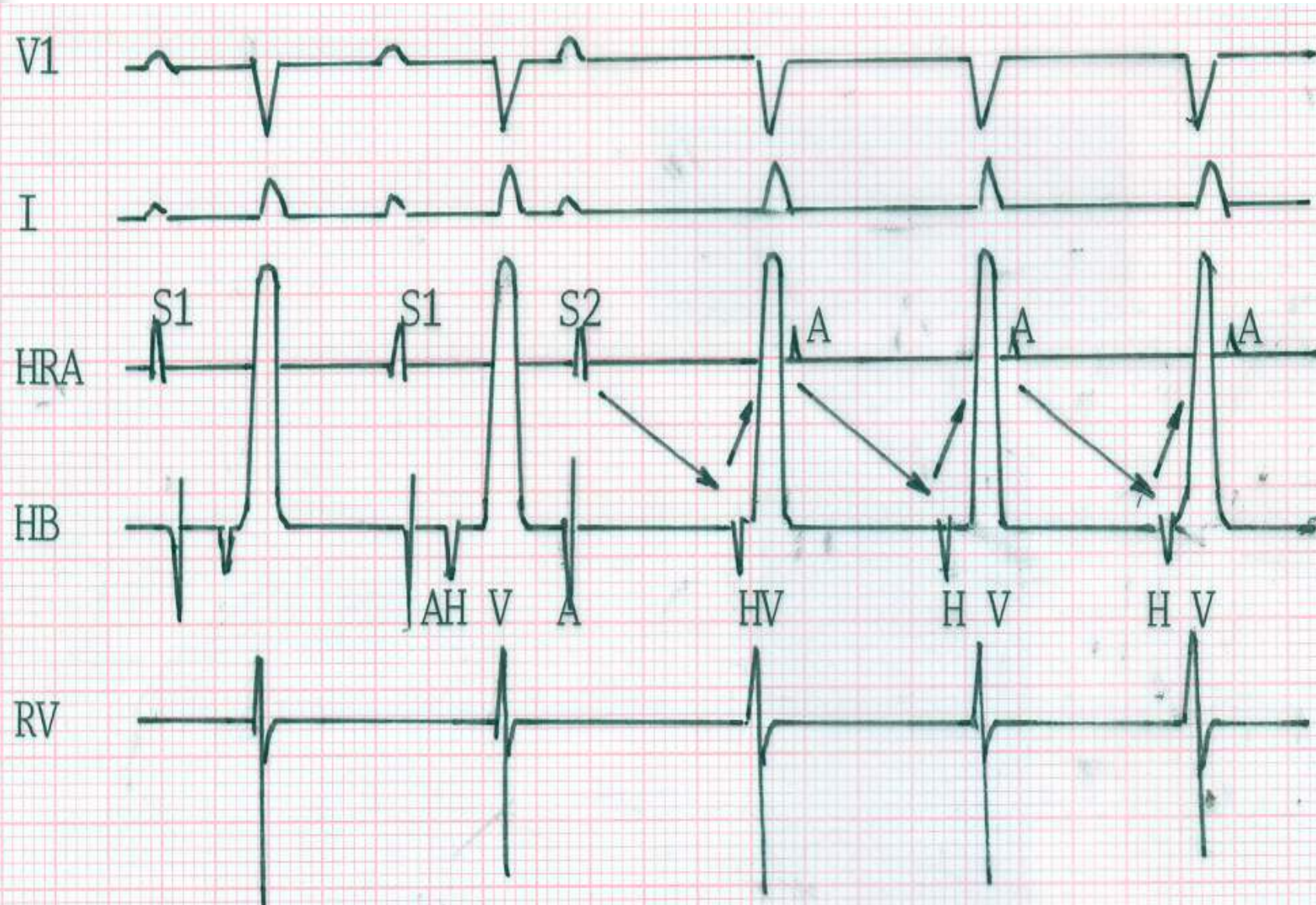


- Rapid atrial pacing or atrial extrastimulus → block in fast pathway with conduction down slow pathway and retrograde conduction up fast pathway →

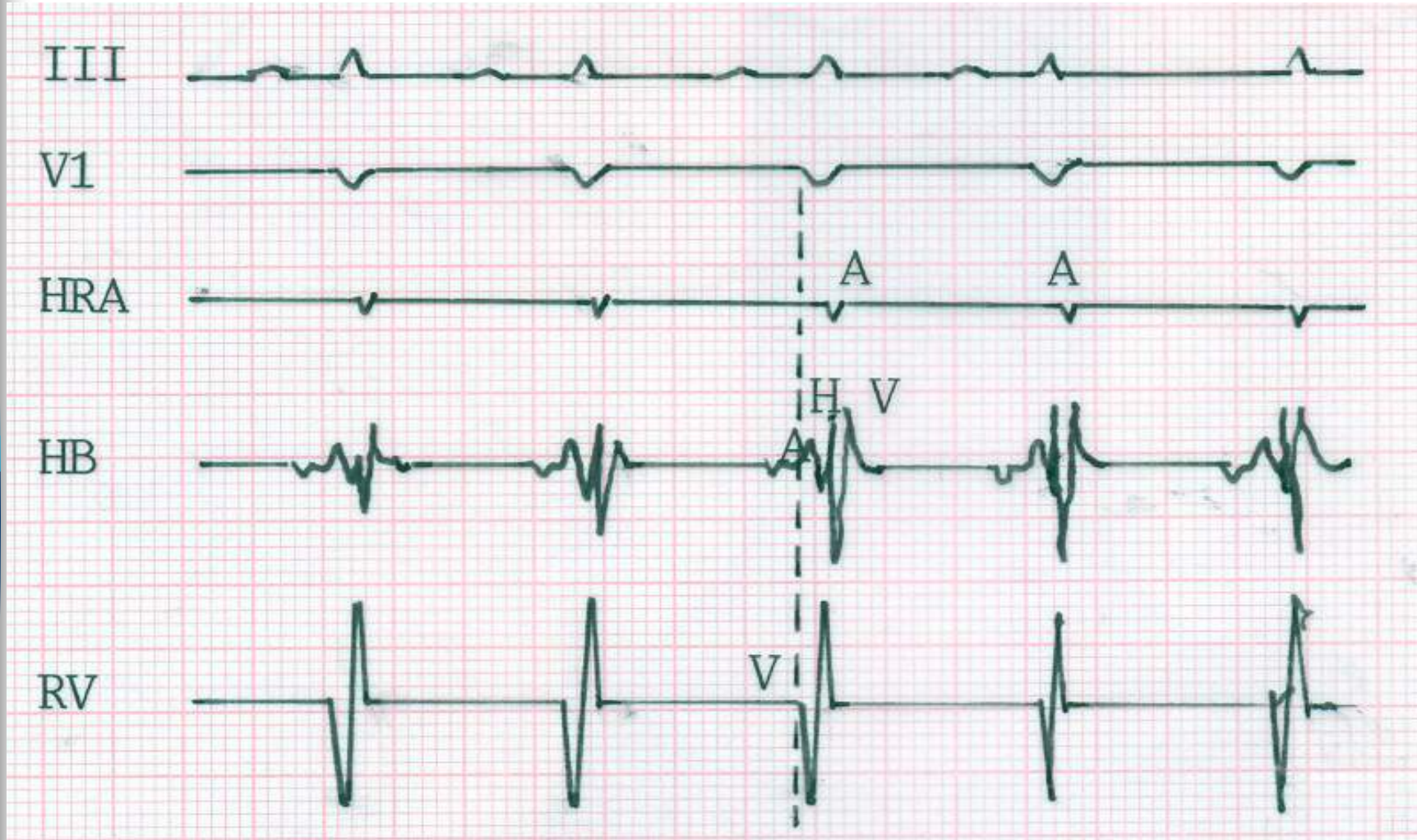
(a) single retrograde atrial beat = “AV nodal echo beat”, indicating presence of AV node reentrant circuit. If add atropine → AVNRT



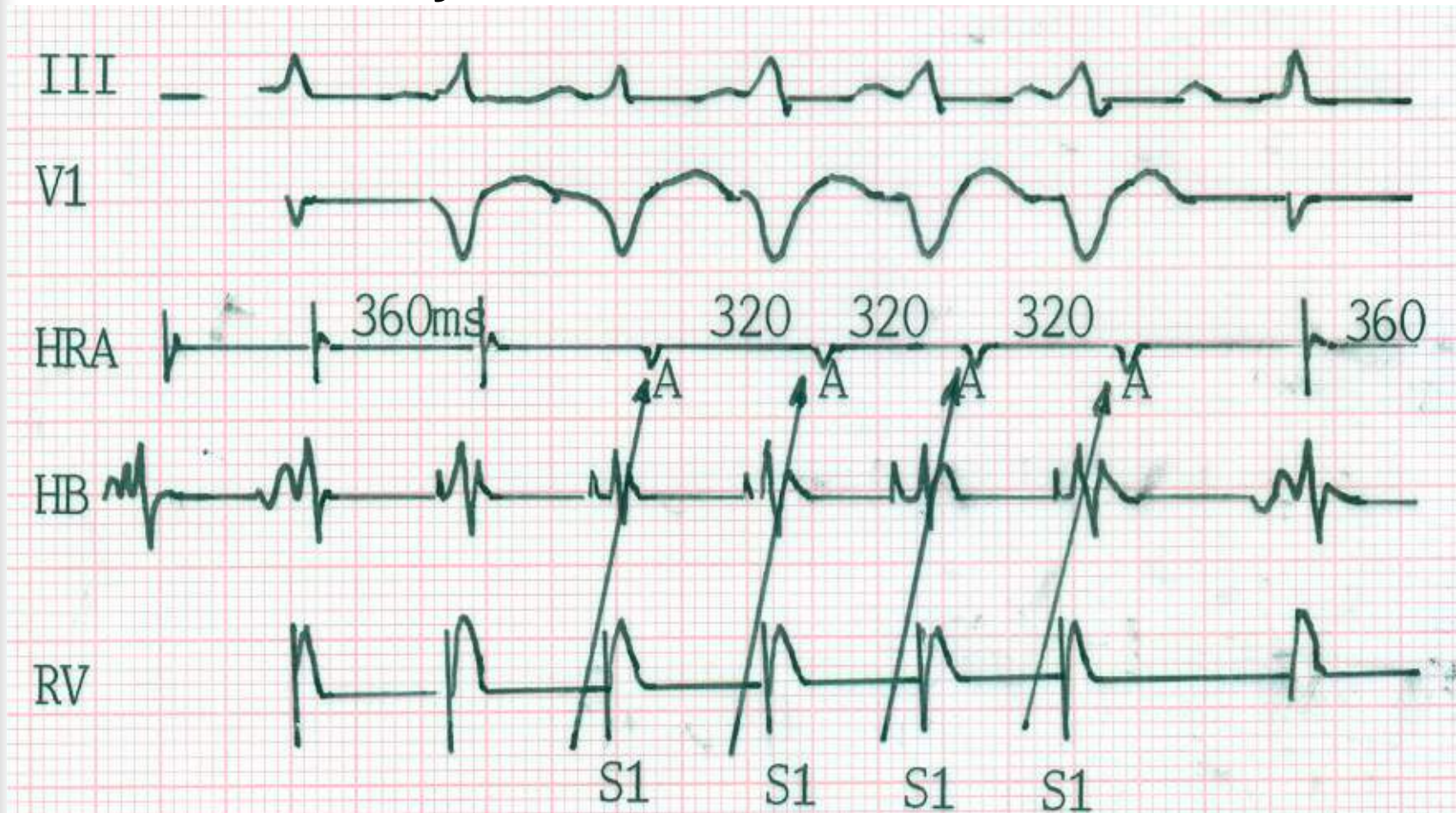
- **AVNRT tachycardia induction (V and A occur nearly simultaneously = characteristic of AVNRT)**



- **Ventricular pacing → ventriculoatrial (VA) conduction** ◦ Earliest site of atrial activation at HIS bundle (=“concentric activation”) with short VA activation time. If no VA conduction, not AVNRT.

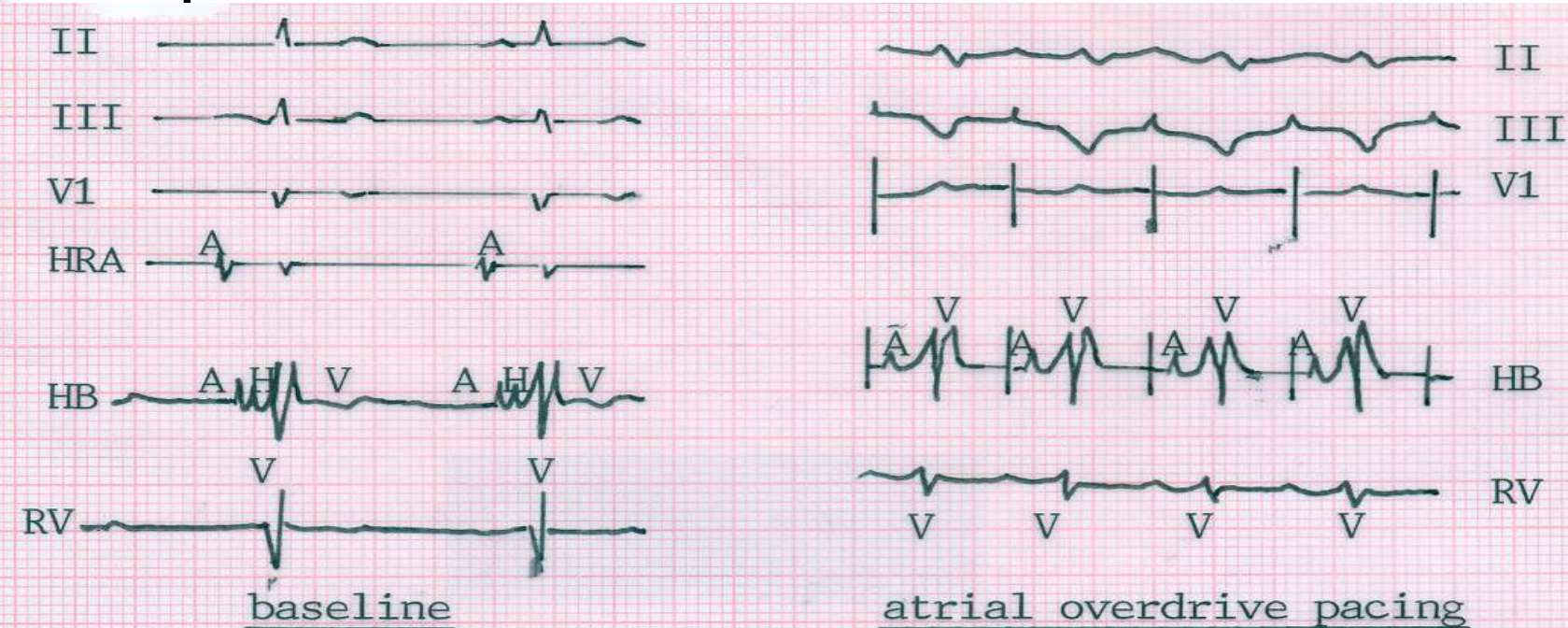


- **Ventricular overdrive pacing → “entrainment of tachycardia”**(ie. Acceleration of AVNRT and upon overdrive termination continues at its original rate and VA timing relationships). If entrainment present, not atrial tachycardia.

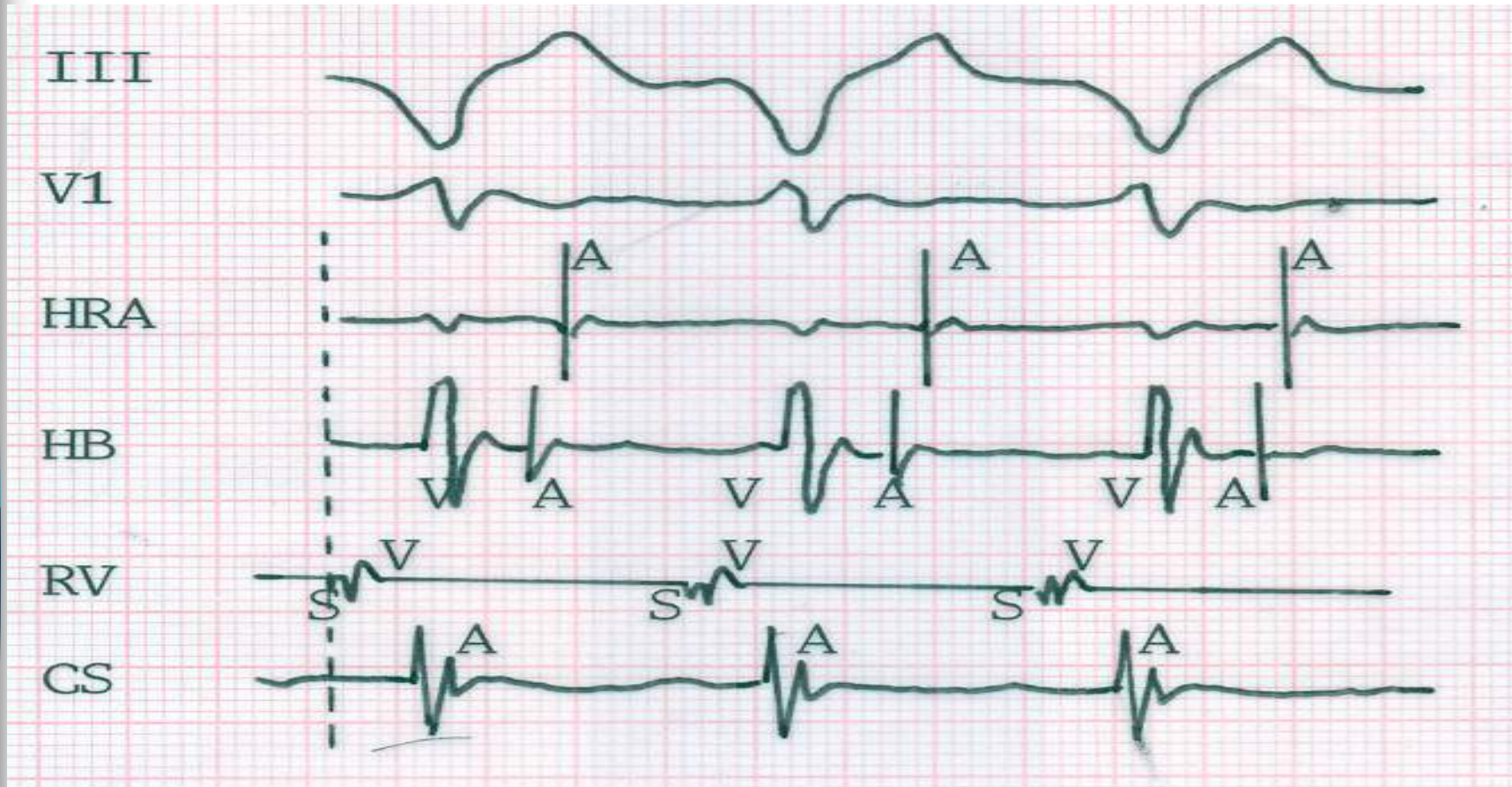


(2) Atrioventricular reentrant tachycardia (AVRT, accessory pathway tachycardia) :

- **accessory pathway = muscle bundles connecting atrium and ventricle, locating anywhere along tricuspid or mitral annulus (commonly on left mitral annulus)**
- **baseline = short HV interval (<35 ms) characteristic of accessory pathway. There is also long VA interval (≤ 100 ms)**
- **atrial overdrive pacing \rightarrow shortening (or buried) HV intervals (vs AVNRT with increasing AH interval) and widening of QRS complex**



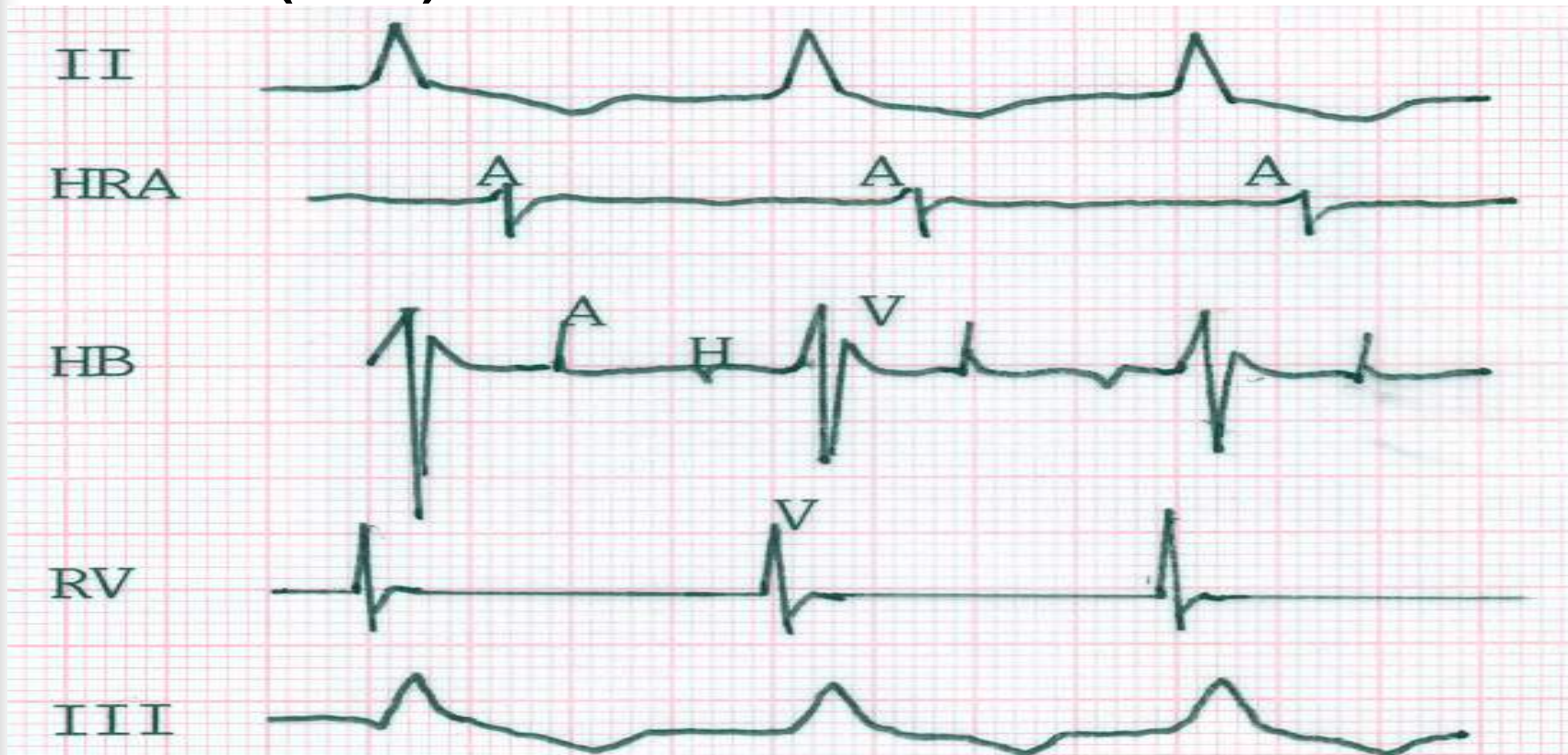
- **Ventricular pacing → “eccentric activation”(ie. Atrium is activated at site other than AV node, here = coronary sinus), diagnostic of presence of accessory pathway**



- **Ventricular overdrive → entrainment of tachycardia**

(3) atrial tachycardia :

- variable AV and VA times
- no entrainment
- earliest site of atrial activation during tachycardia is not at AV node (as in AVNRT), here = high right atrium (HRA)



Ventricular tachycardia

(1) Abnormal automaticity :

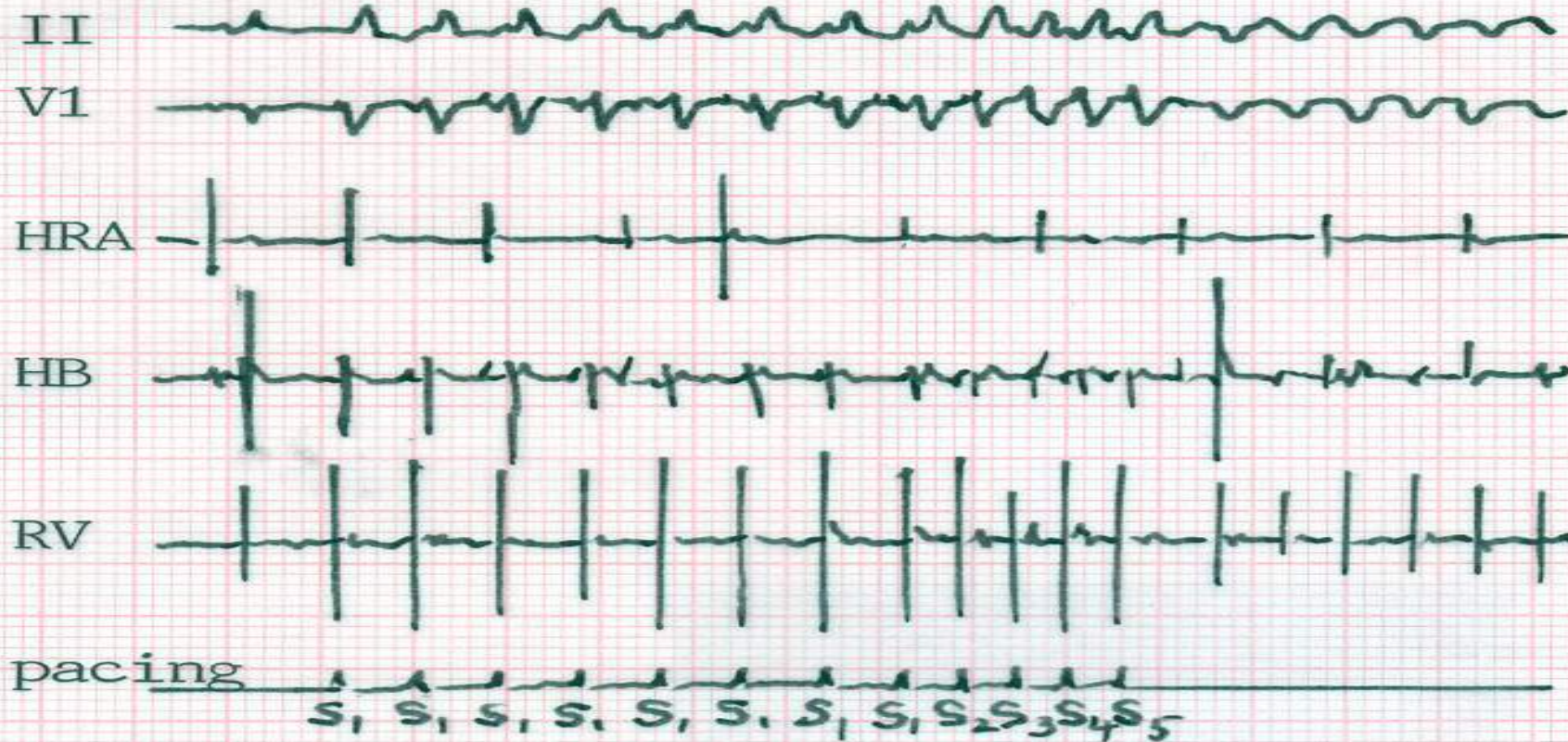
- polymorphic with beat-to-beat variation in QRS morphology
- gradual increase and decrease in heart rate at initiation and termination of VT, respectively.
- usually provoked by ischemia, electrolyte imbalance, metabolic disorders
- usually not induced by ventricular programmed stimulation during EPS

(2) Triggered activity :

- monomorphic
- gradual increase and decrease in heart rate at initiation and termination of VT, respectively.
- usually provoked by adrenergic stimulation
- often inducible with overdrive ventricular pacing or ventricular programmed stimulation during EPS

(3) Reentry:-

- monomorphic
- abrupt onset and termination of VT
- often inducible with ventricular programmed stimulation during EPS



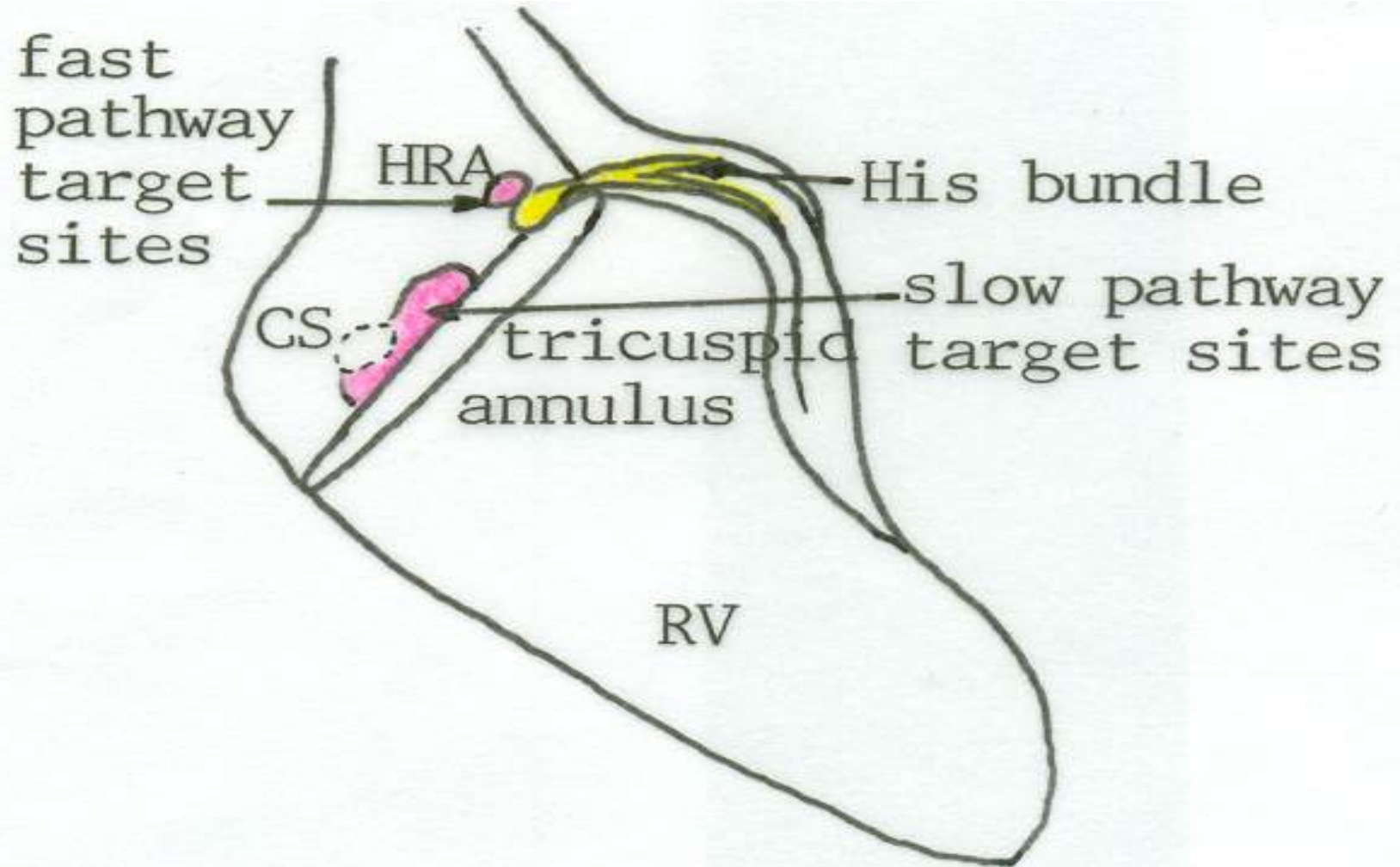
- Drive of eight pacing impulses (S1) followed by 4 extrastimuli (S2,S3,S4,S5) with subsequent initiation of sustained monomorphic ventricular tachycardia. Coupling intervals between drive train and extrastimuli progressively shortened until failure of first extrastimulus to capture (ventricular refractoriness)

Radiofrequency catheter ablation therapy

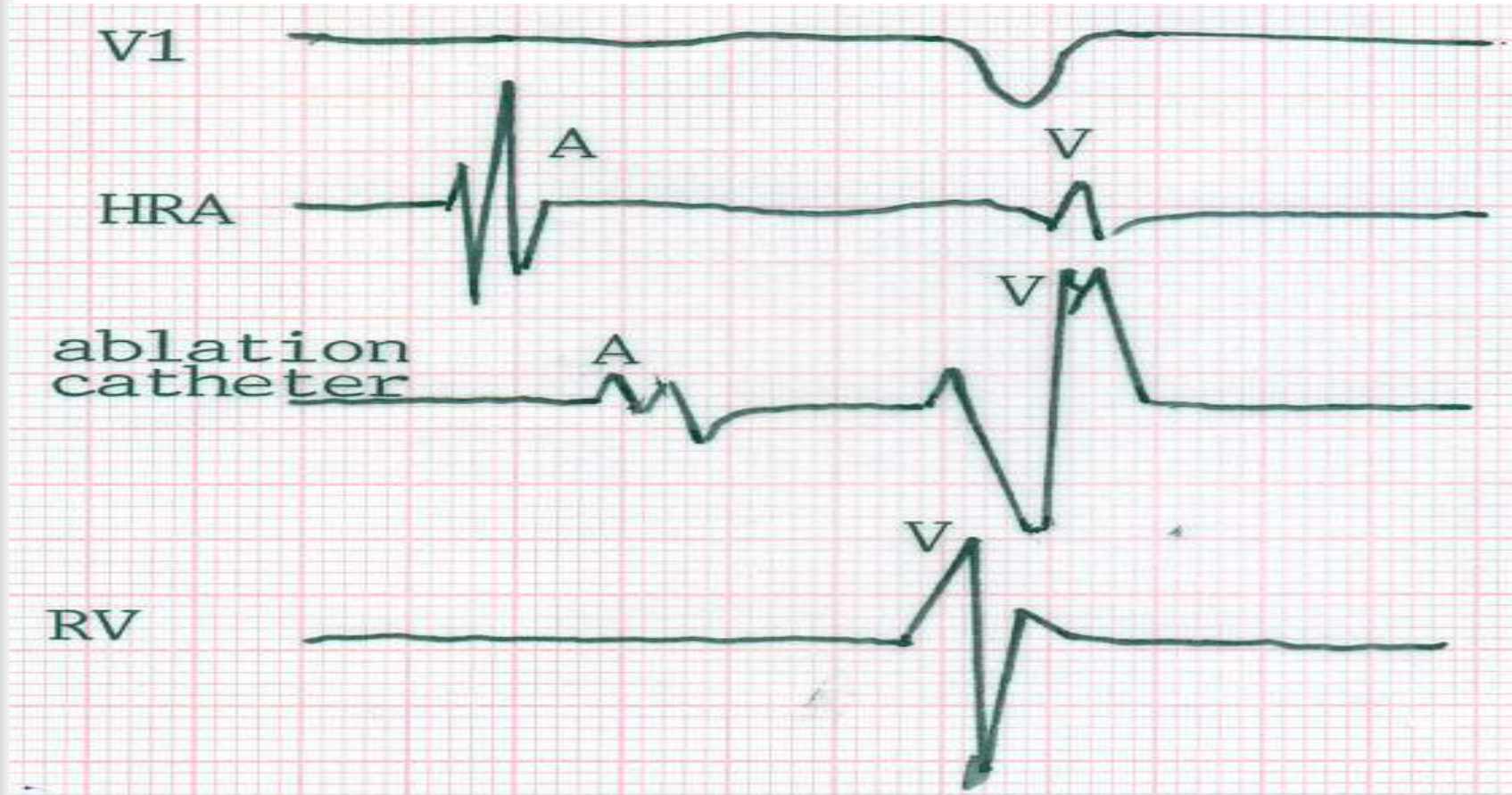
- To destroy myocardial tissue related to the arrhythmias (=target tissue) by delivering radiofrequency (RF) energy with controlled heat production from an external generator
- For treatment of supraventricular and ventricular arrhythmias

Atrioventricular node reentrant tachycardia (AVNRT)

■ Usual target locations in AVNRT :



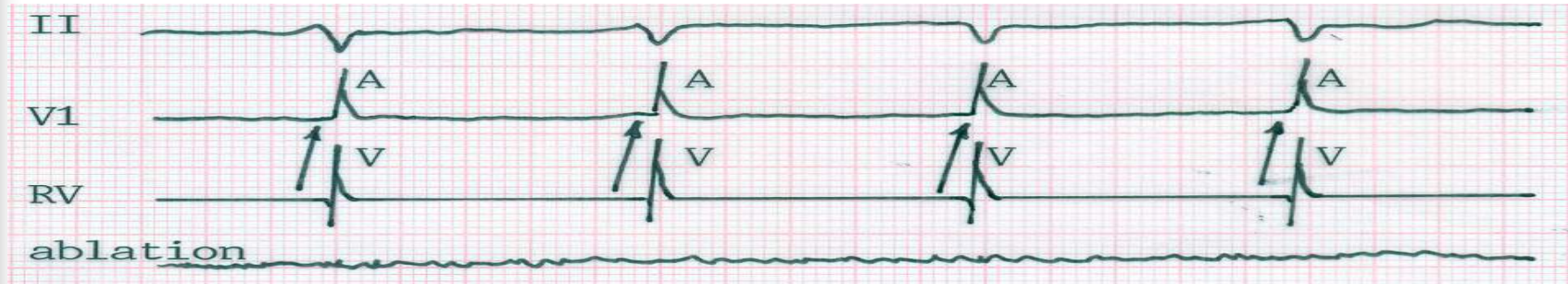
- **Mapping:** ablation catheter positioned along tricuspid annulus inferior to HIS bundle recording area near coronary sinus ostium, with no HIS potential, and atrial/ventricular electrogram ratio < 0.5 . If HIS potential present, change to another site so as to avoid risk of complete heart block



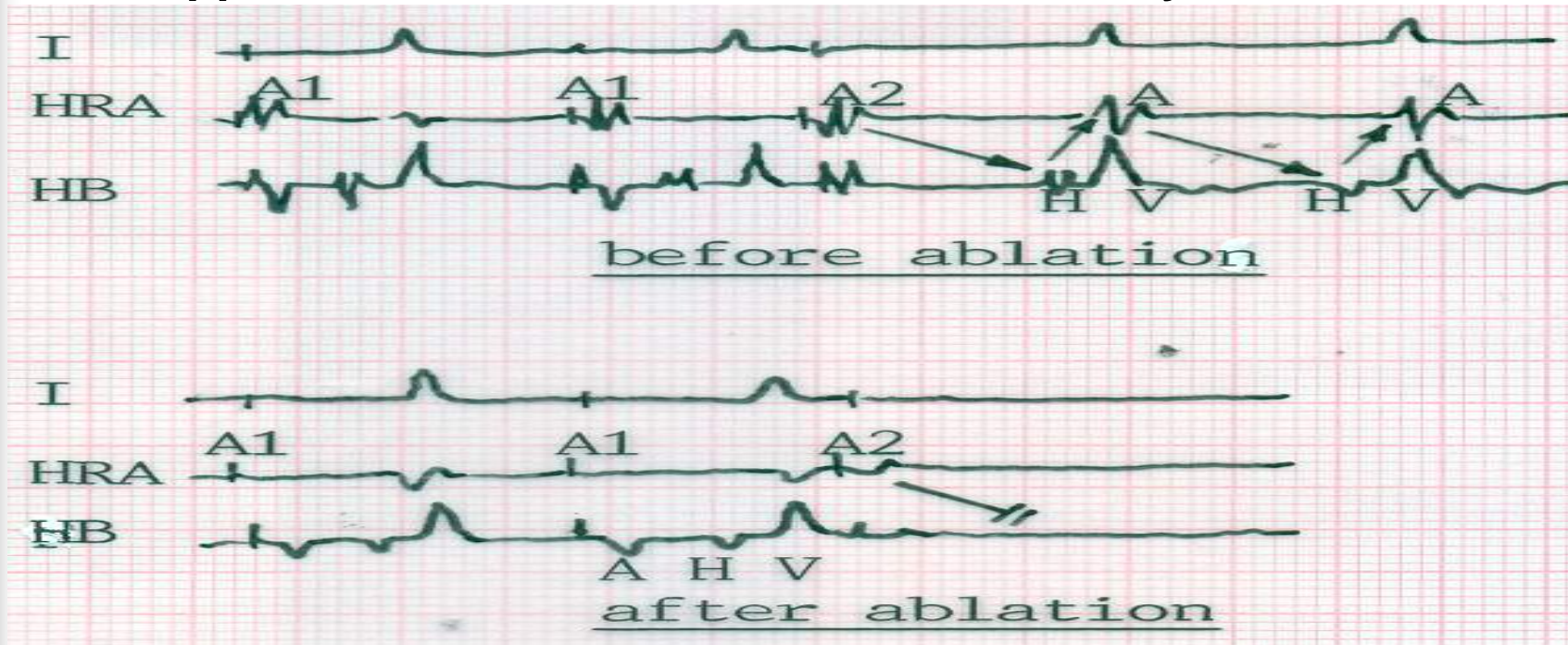
- **Radiofrequency application:** power output 25-40 watts • Successful slow pathway ablation → junctional rhythm and elimination of inducible AV nodal jump and tachycardia. If VA block (=predictor of complete heart block) occur, stop RF application immediately.

■ **Determinants of success:**

RF application → junctional beats



RF application → elimination of inducible tachycardia



■ **Complication:** complete heart block (<1% for slow pathway approach)

Accessory pathway ablation

- **Mapping:** ablation catheter positioned along tricuspid (right-side accessory pathway) or mitral (left-side accessory pathway) annulus with earliest local ventricular electrogram time relative to onset of QRS complex (here = ablation catheter, V coincide with QRS complex)



- **Radiofrequency application:** 25-35 watts for 30-60 sec
- **Determinants of success:** loss of preexcitation

■ ***Atrial tachycardia ablation :***

ablation catheter move around atria during tachycardia for site of earliest atrial activation, RF current 20-35 watts for 30-60 sec, and success indicated by termination of the tachycardia

■ ***Atrial flutter ablation:***

ablation catheter positioned in inferior vena cava – tricuspid valve isthmus, RF current 25-50 watts for 60-90 sec, and success indicated by termination of atrial flutter

■ **Atrial fibrillation ablation:-**

ablation of atrioventricular junction with RF current 25-35 watts for 30-60 sec → complete heart block and pacemaker required

■ **Ventricular tachycardia ablation:**

ablation catheter move in right or left ventricle (depending on chamber from which VT originates). If QRS configuration during pacing match that of electrocardiogram, RF current 25-35 watts for 30-60 sec, and success indicated by inability to reinduce the tachycardia