

Module 1:

Introduction to ECG & Normal ECG

Importance of Correct anatomical positions

- Measurements & Morphologies ONLY accurate if
 - Precise anatomical positions adhered to
 - Standardised techniques are used

ECG Equipment Settings

- Frequency Response
 - 0.05Hz – 150Hz
 - companies often set these at 0.5 Hz – 50HZ
 - These are filtered ECGs and can alter isoelectric line placement & morphologies
- Gain sensitivity – calibration accuracy
 - 5, **10**, 20mm/mV (standard 10mm/mV)
- Chart paper speed
 - **25mm.sec** – standard
 - 50mm/sec

Precordial (Chest) leads

- Variations in precordial lead placement DIAGNOSTICALLY affects the ECG
- Studies have shown V1& V2 are consistently placed TOO HIGH
- Correct anatomical positions should be used
- Deviations must be annotated on ECG

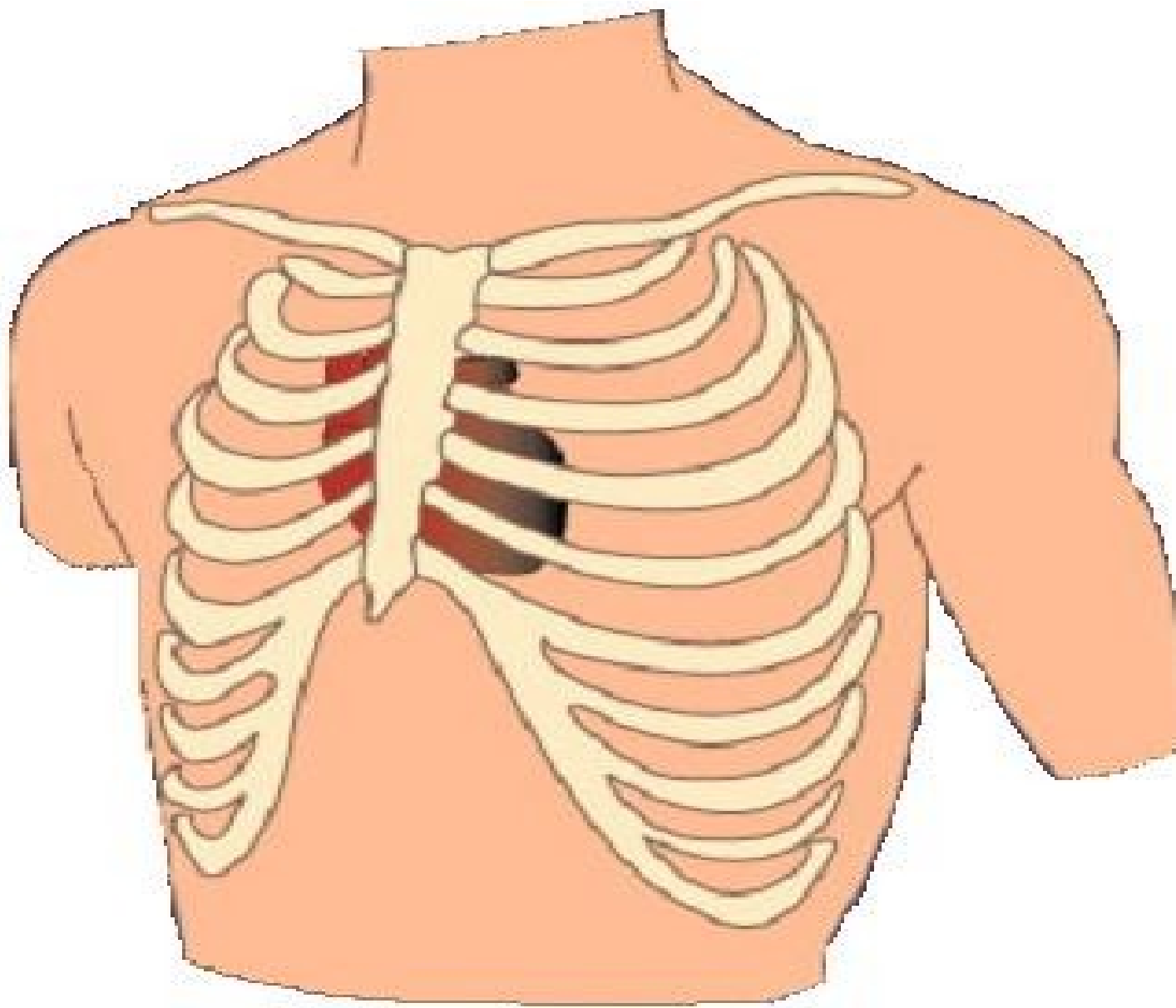
Chest lead placement

- V1- 4th intercostal space at right sternal edge
- V2 – 4th intercostal space left sternal edge (not always dead opposite V1)
- V3 – midway diagonally between V2 & V4
- V4 Fifth intercostal space mid-clavicular line. (Not under nipple, remember ribs curve around the chest)
- V5 – Left anterior axillary line at same horizontal plane as V4- (lay the arm straight down the side, the electrode goes in the crease in a line with V4)

Modified from SCST (2010)

• middle of the arm pit in a straight line with V5
V6- mid-axillary line in a horizontal plane with V5 (line from the middle of

Modified from SCST (2010)



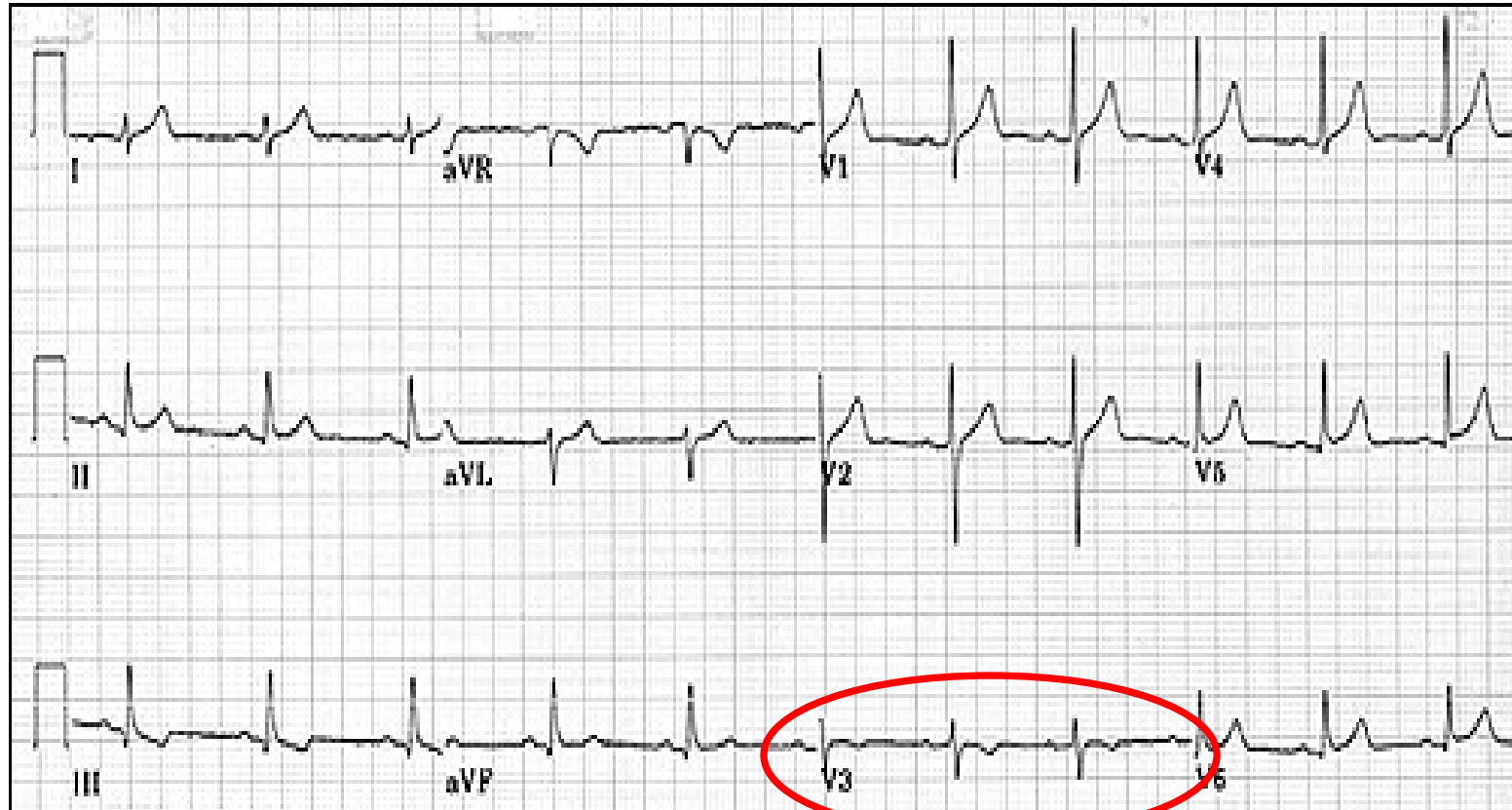
Quick Guide

- Measure from sternal notch NOT clavicle
- V4 mid clavicular NOT necessarily under the nipple
- V4 under breast tissue NOT above
- V4-V6 placed horizontally NOT curving up following rib cage

What should a Normal ECG look like?

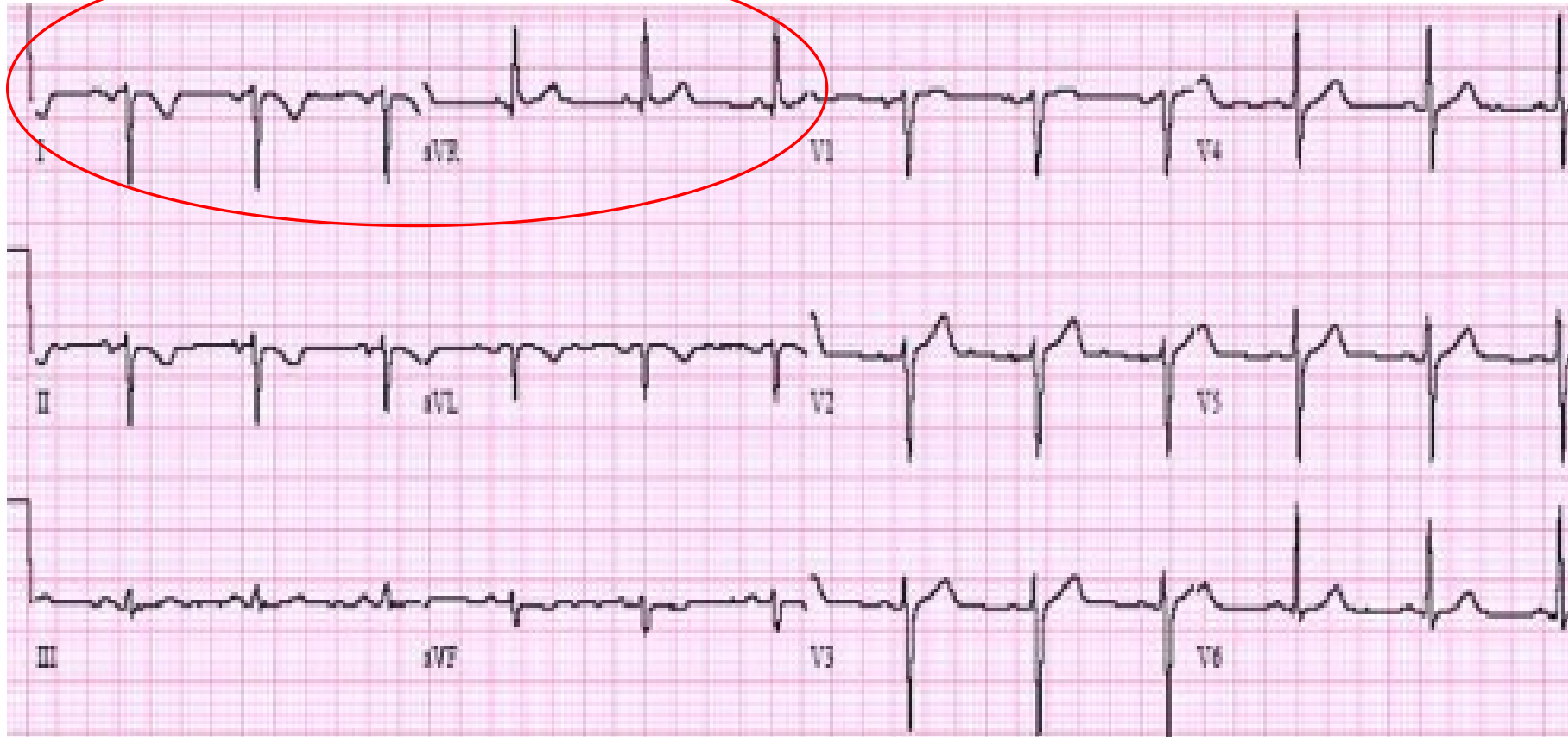
- Positive in lead 1
- Negative in aVR
- Increase in R wave progression V1- V5 (V6 can be a little smaller)
- 1 P wave for each QRS
- Normal morphologies
- Normal intervals

Transposition of V1 and V3



Poor R wave Progression (note V3)

Technical Dextrocardia



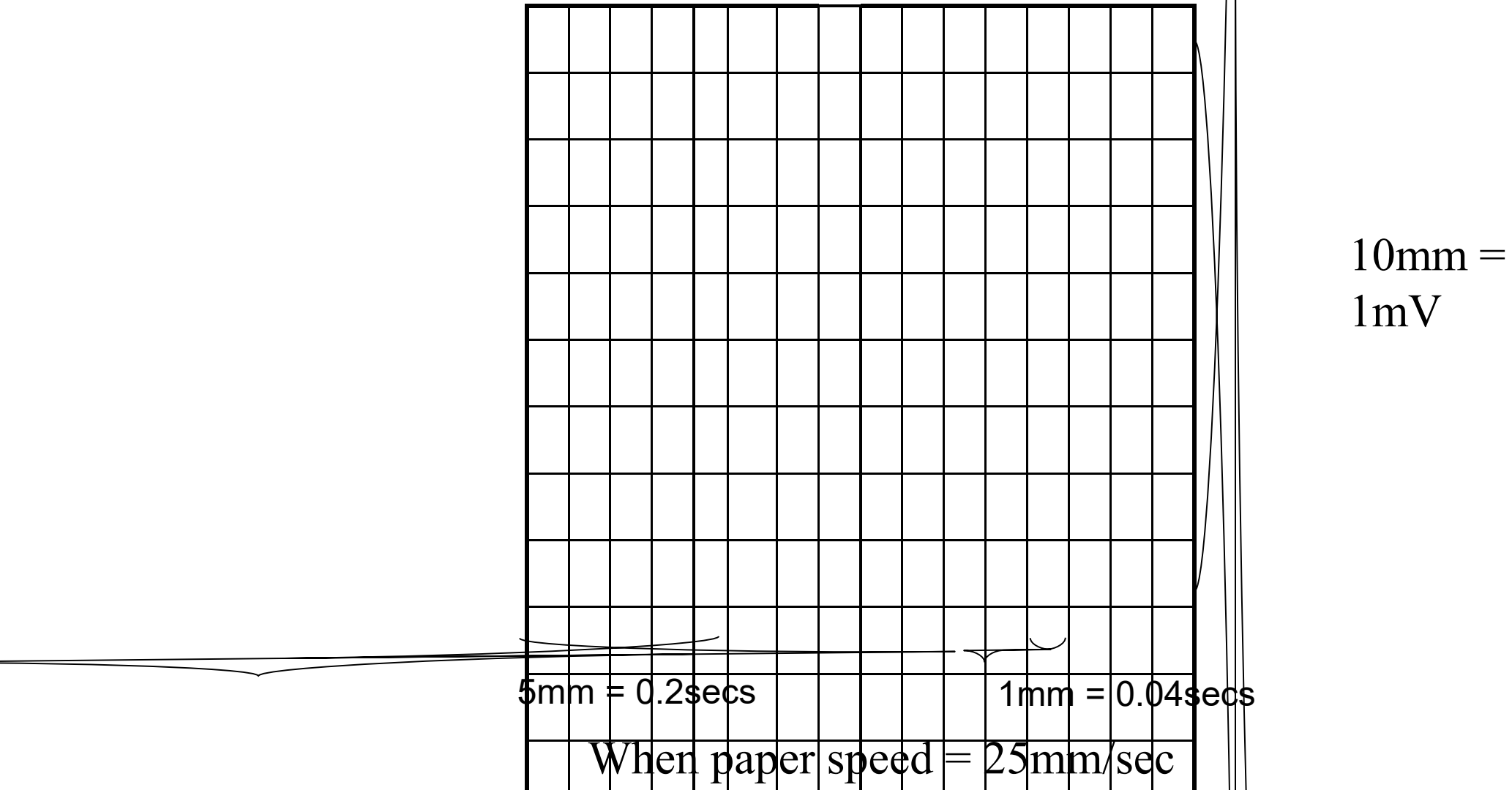
Right and left arm transposed
(if not consider true dextrocardia)

References

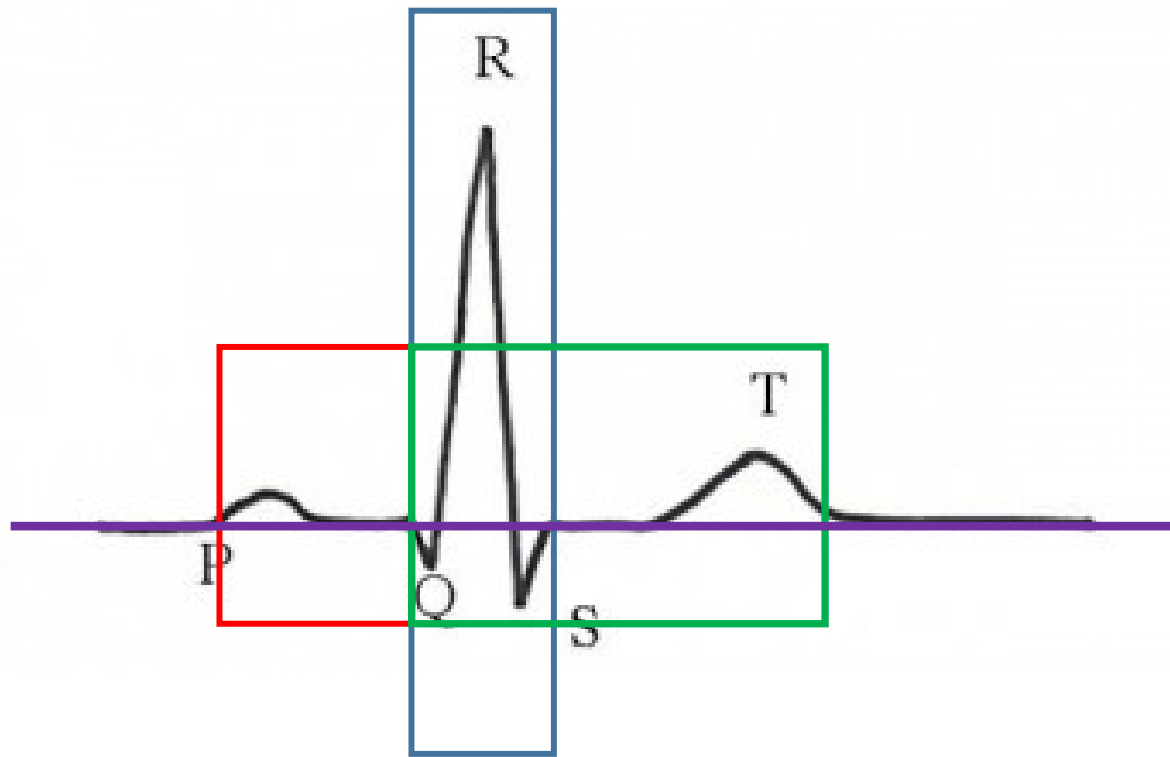
- Useful reading / guidelines
- Crawford J & Doherty L ; Practical Aspects of ECG Recording: M&K publishing 2012
- Society of Cardiological Science & Technology and the British Cardiovascular Society. (2010) Clinical Guidelines by consensus: Recording a standard 12-lead ECG an approved methodology. Available at http://www.scst.org/resources/consensus_guideline_for_recording_a_12_lead_ECG_Rev_072010bpdf

Normal ECG

ECG Paper



Intervals



□ PR interval – Beginning of P wave to beginning of QRS complex (0.12 -0.2 secs)

□ QRS complex - < 0.12 secs

— ST segments - isoelectric line

□ QT interval –

$$QTc = \frac{QT \text{ interval}}{\sqrt{RR \text{ interval}}}$$

Where QT & RR are measured in time (secs)
(< .44secs)

Normal Heart rates

- Fetus – varies from 120-160 bpm
- Neonate – 70bpm when sleeping, upto approx 180bpm when active
- Week old baby at rest – 140bpm
- Year old – 120bpm
- By 6 years old – average rate of <100bpm
- Adolescent – 80bpm
- Normal adult – 60-100bpm
- The wide range of normal for an adult depends on fitness, emotional stress , physical activity etc.

Sinus rhythm, no abnormalities

Against which all other ECGs can be measured



ECG interpretation process

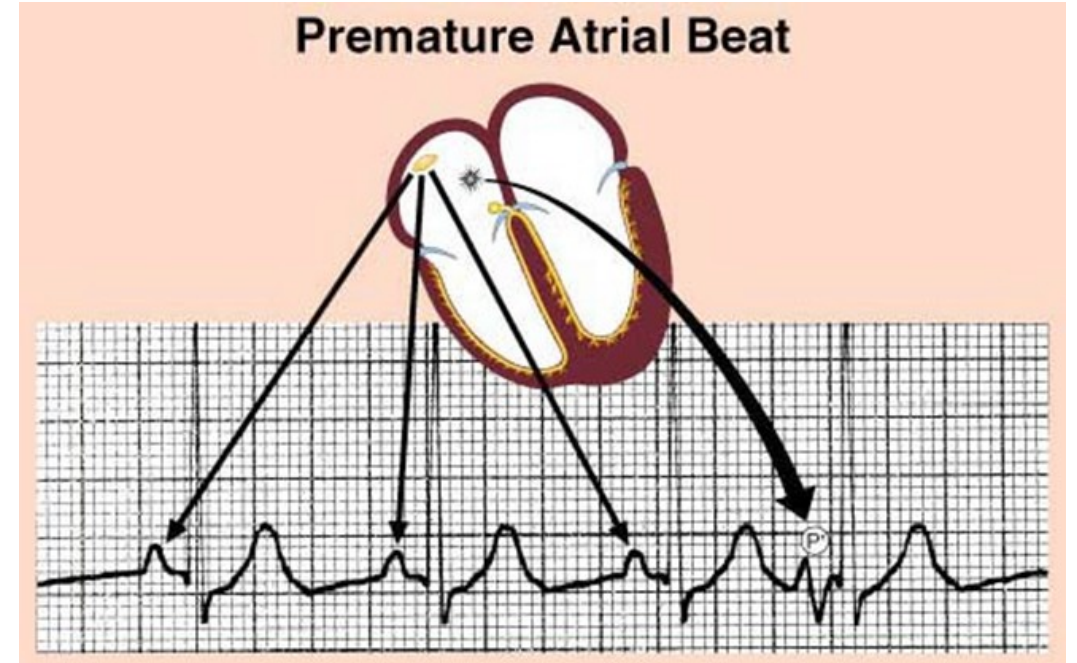
1. Is there a clear definable P wave? YES
2. Is there 1 QRS for every P wave ? YES
3. Is it regular or irregular ?
Could be both (sinus arrhythmia)
4. Intervals ?
NORMAL
5. Morphologies?
NORMAL

Module 2

ATRIAL FIBRILLATION

Atrial ectopic beat

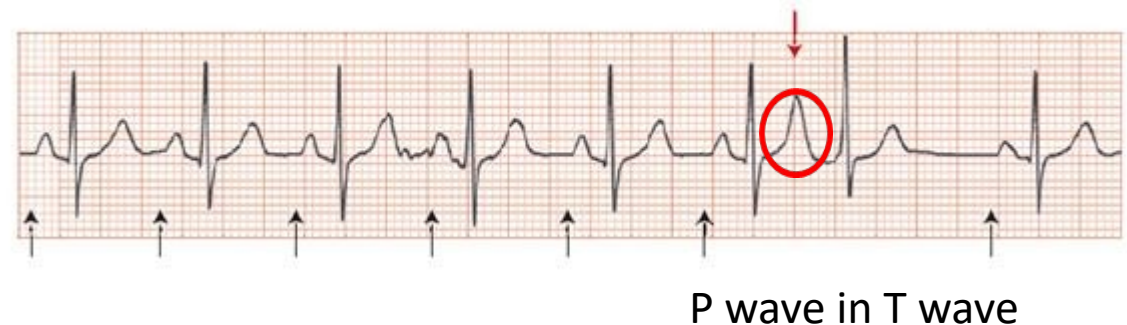
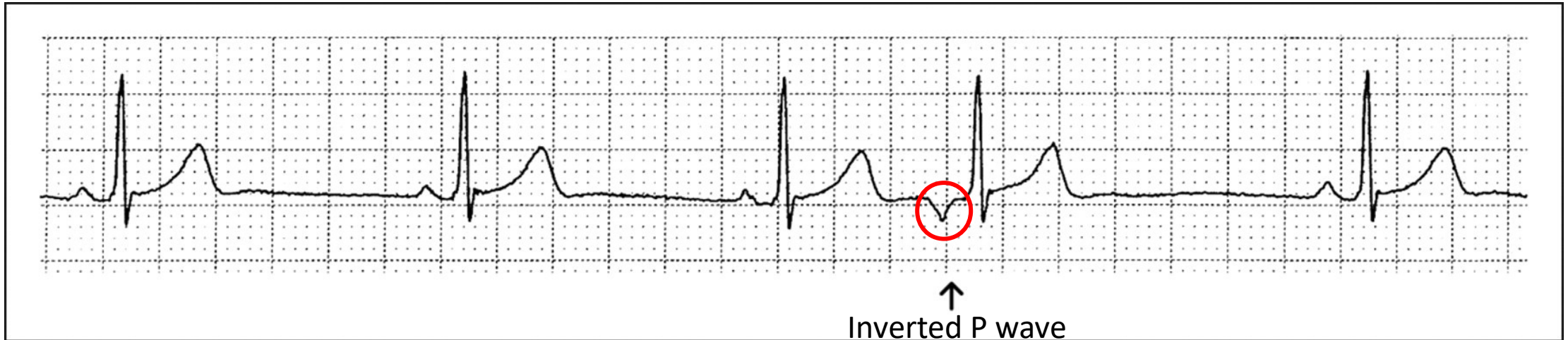
- Premature Normal
- SVE
- Premature
 - Occurs in diastolic period of preceding sinus beat
 - Seen earlier than the next expected sinus beat
- Bizarre
 - Origin of ectopic is a focus other than the SAN
 - P wave will have different morphology



P wave morphology

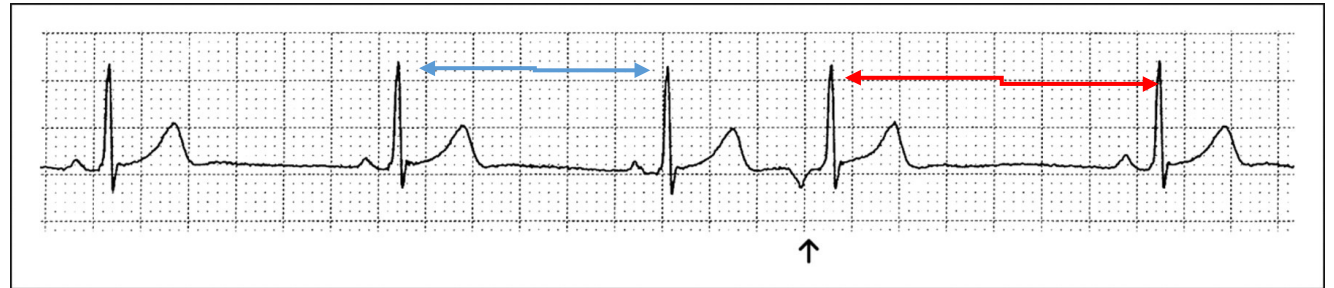
different morphology to sinus P wave

(maybe very subtle)



Compensatory Pause

- Sinus rhythm has been disturbed
- Compensatory pause following ectopic beat
- Early beat , causes heart to go through a complete recovery phase before SAN can discharge again.



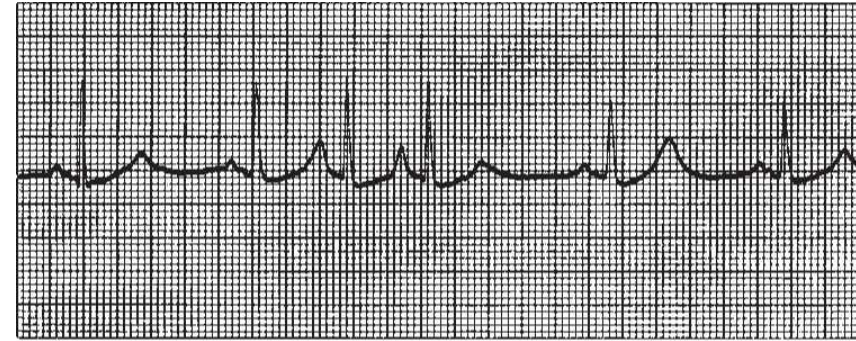
↔ Sinus RR interval
↔ Compensatory Pause RR interval



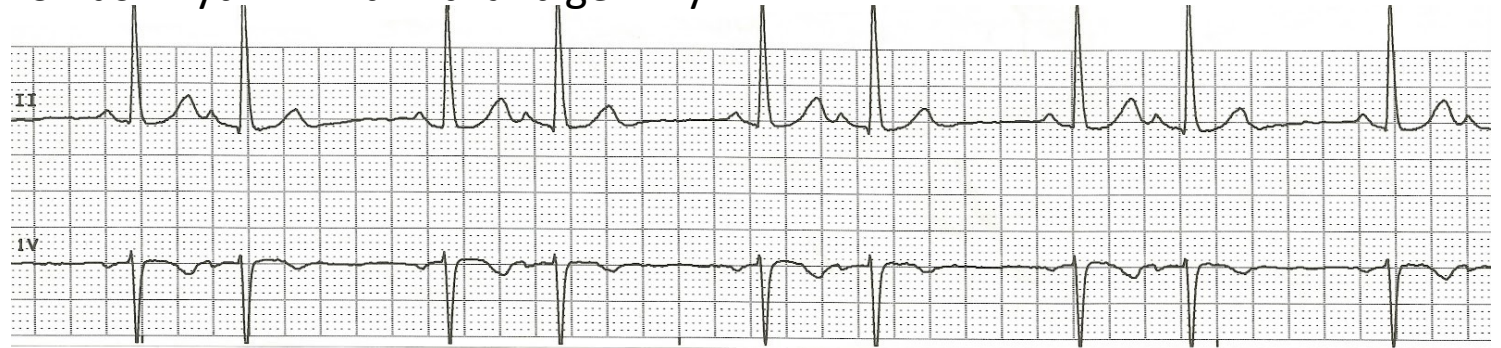
Multiple atrial ectopics

- **Couplet** – 2 consecutive premature beats
- **Triplet** – 3 consecutive premature beats
- **Salvo** – more than 3 consecutive atrial ectopics
- **Atrial bigeminy** – 1 normal beat followed by premature beat followed by normal beat

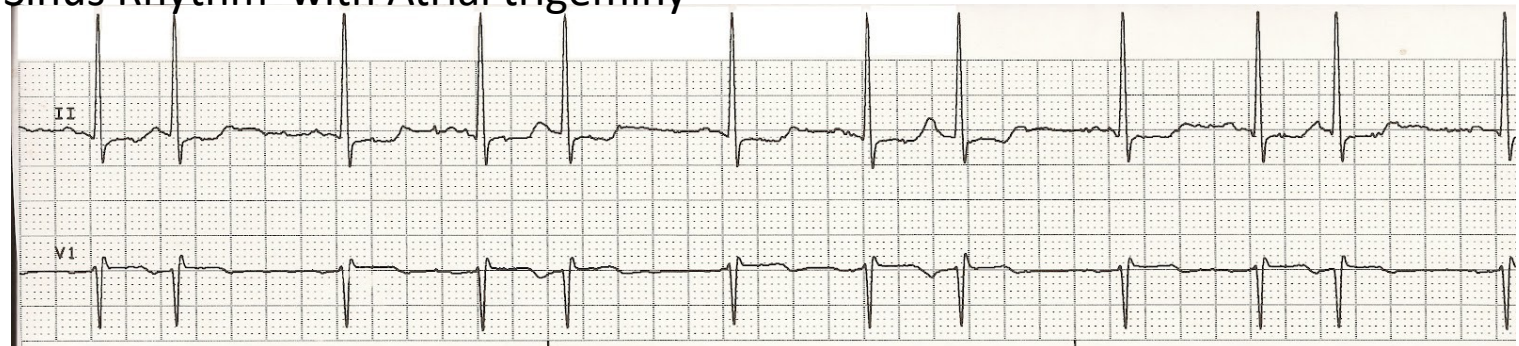
Atrial couplet



Sinus Rhythm with Atrial bigeminy

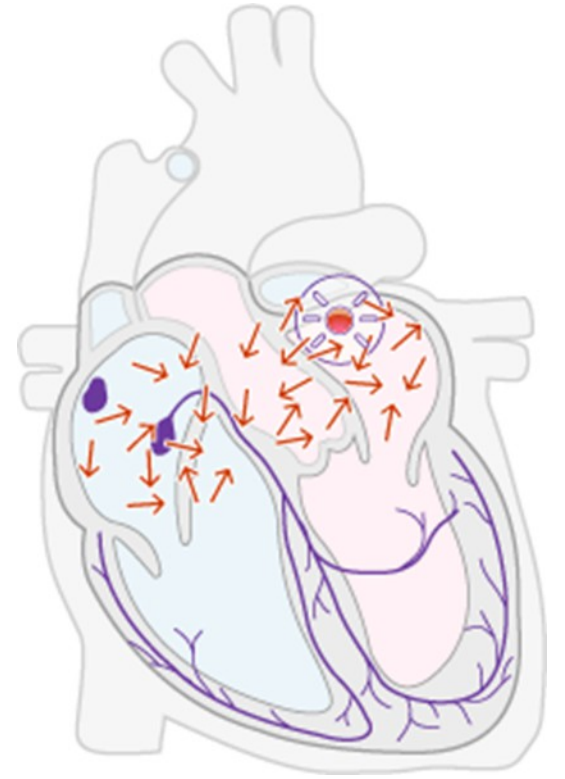


Sinus Rhythm with Atrial trigeminy



Atrial fibrillation

- Uncontrolled, chaotic atrial rhythm
- Disorganised excitation & recovery of atrial muscle
- Impulse reached AVN at frequent yet irregular intervals- some are stronger than others
- AVN can only conduct some of these impulses due to the refractory period
- Pulses reaching the AVN during the refractory period are blocked
- Respiration, emotion, vagal stimulation & exercise can vary the refractory period



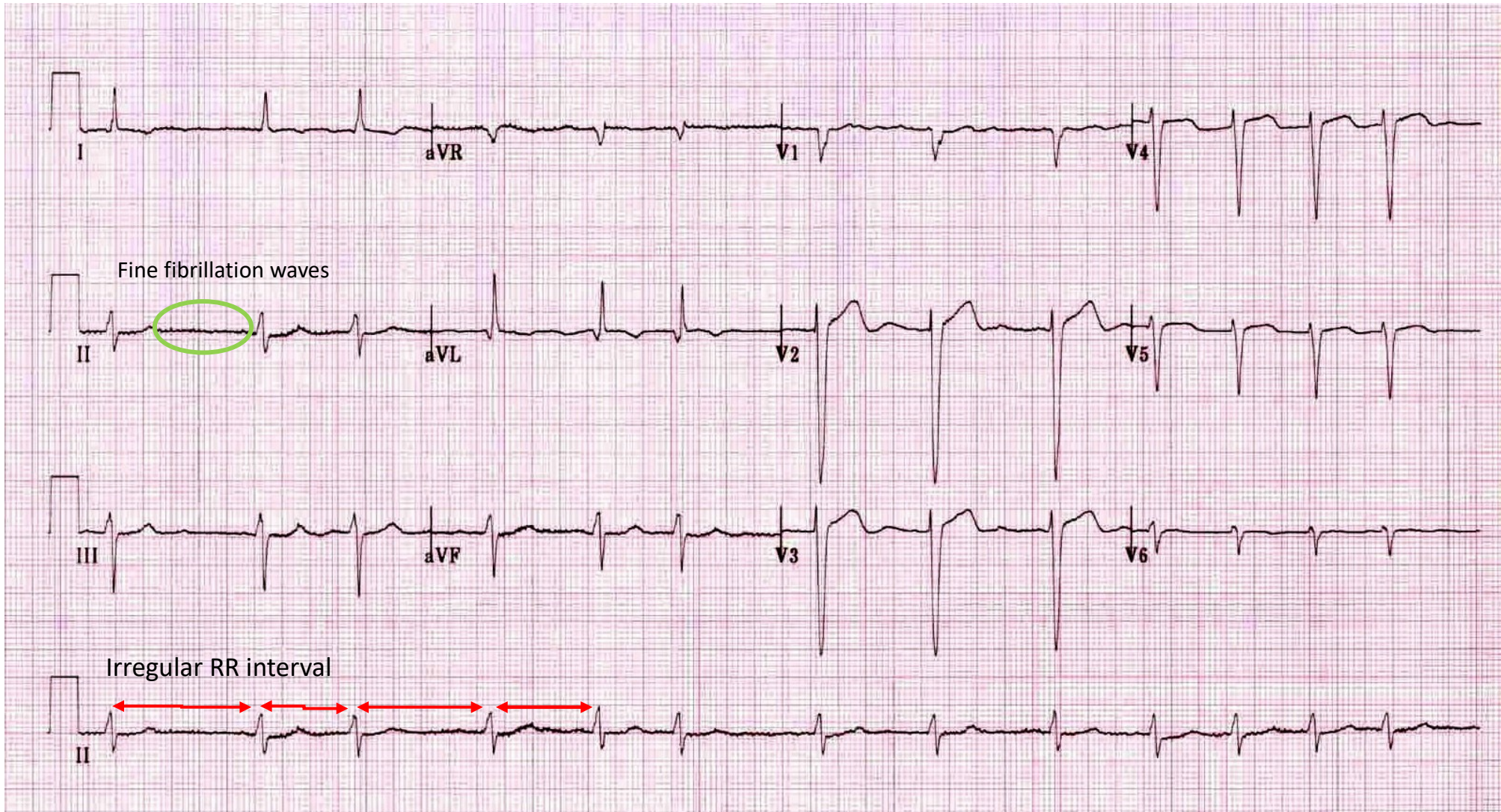
Atrial fibrillation

ECG Criteria

- P wave – absent
 - Small, rapid irregular fibrillation waves (can look like muscle tension)
- Rhythm – irregular
- QRS – normal duration (unless inter- ventricular conduction delay)
- Rate – can be fast or slow or both - depending on AVN conduction



Fine AF



ECG Rhythm interpretation process

1. Is there a clear definable P wave?
NO
2. Is there 1 QRS for every P wave ?
N/A (no P waves)
3. Is it regular or irregular ?
IRREGULAR
4. Intervals ?
No PR interval
NORMAL (QRS)
5. Morphologies?
NORMAL

Course Atrial fibrillation



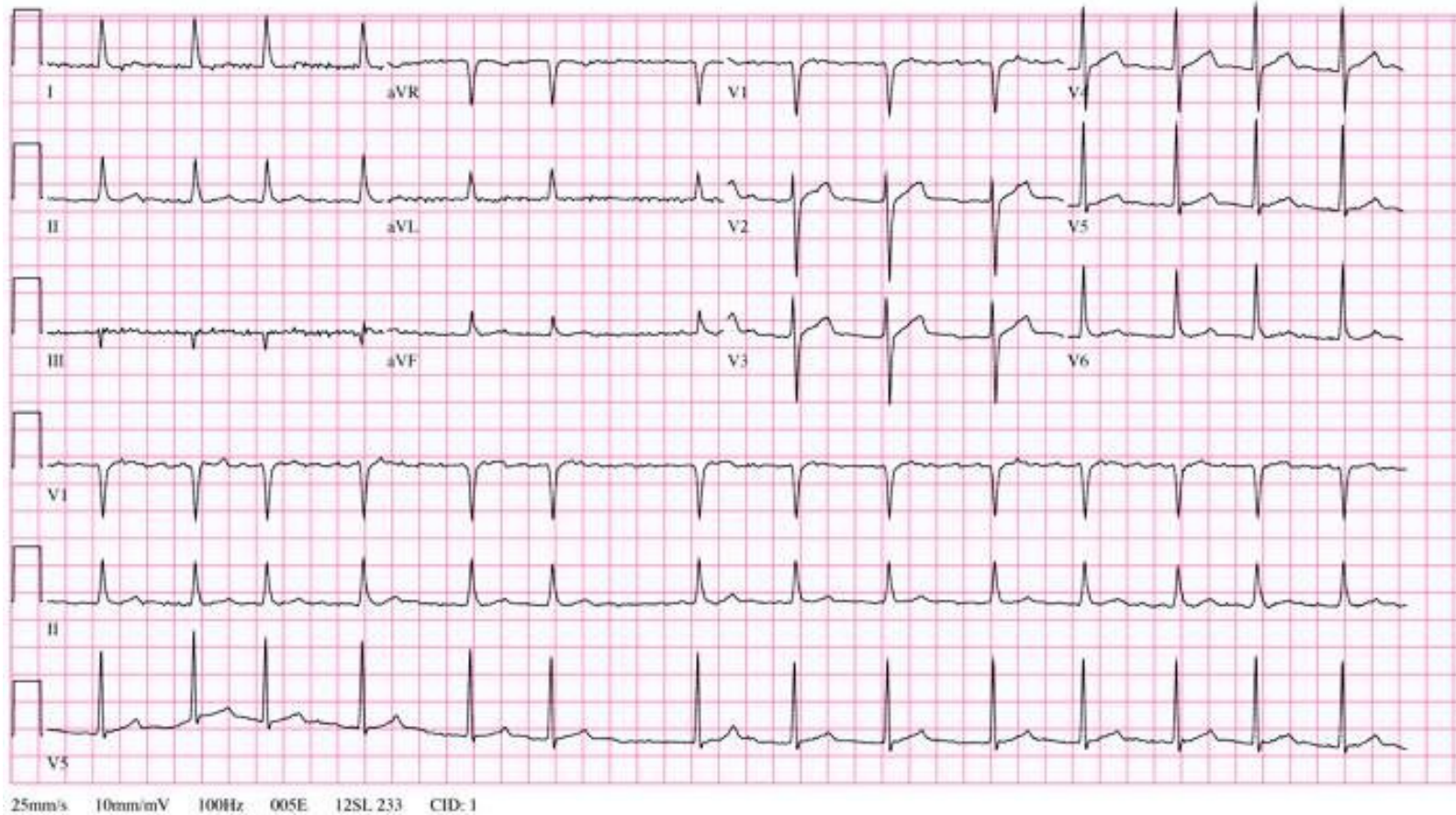
Course
fibrillations
waves

Often confused
with Atrial
flutter

No clear “saw-
tooth “pattern

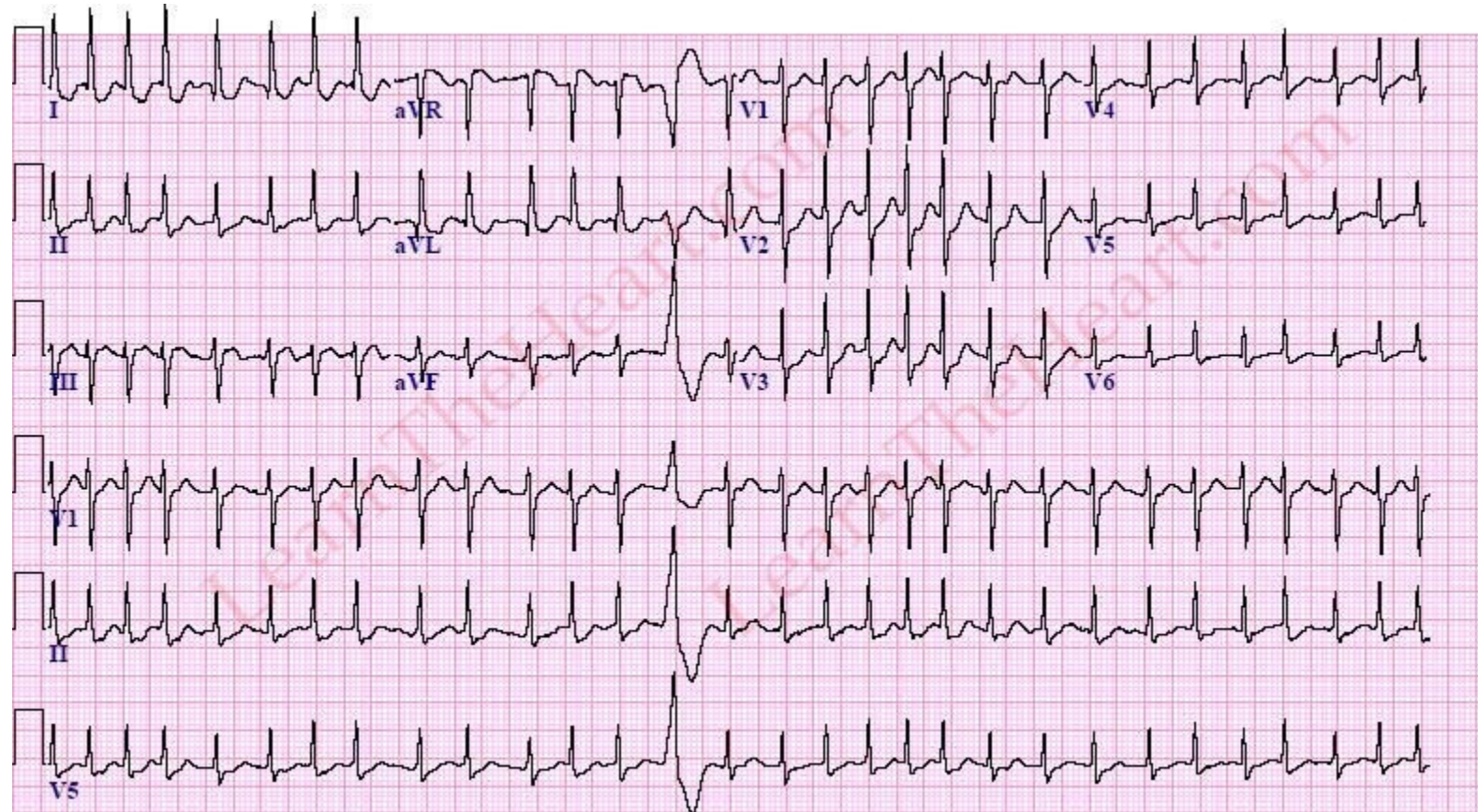
Irregular RR
interval

Atrial fibrillation with Rapid Ventricular response



AF with Heart Rate
100-150 bpm

Fast Atrial fibrillation



25mm/s 10mm/mV 40Hz 005C 12SL 254 CID: 29

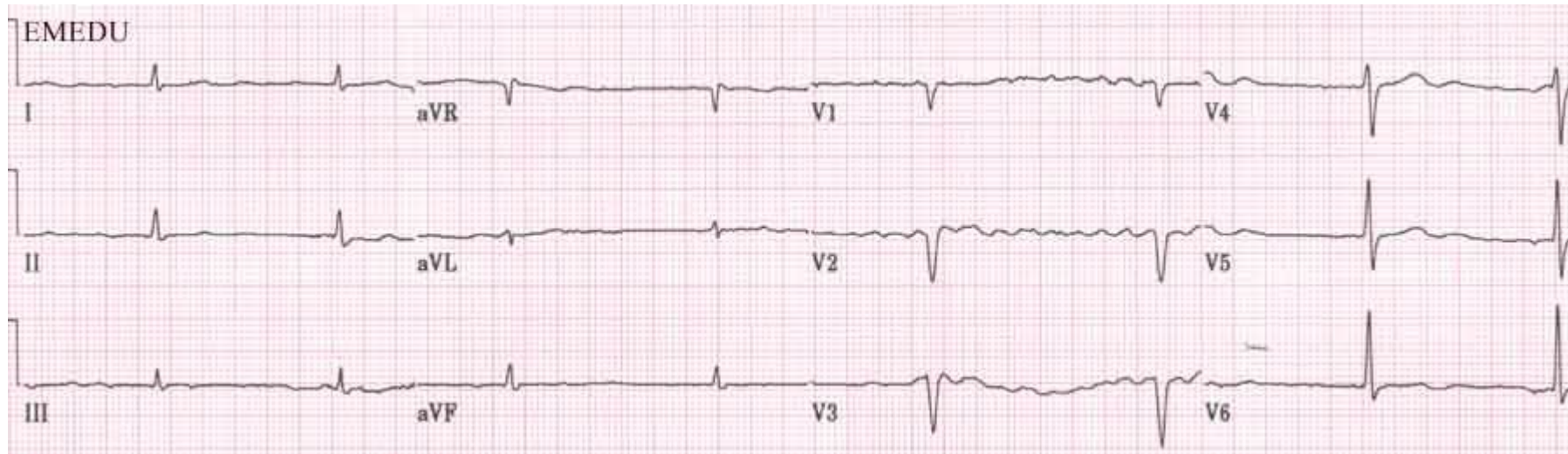
EID:615 EDT: 10:18 27-OCT-2002 ORDER:

No P clear definable
consistent P wave

Irregular RR interval

HR > 150bpm

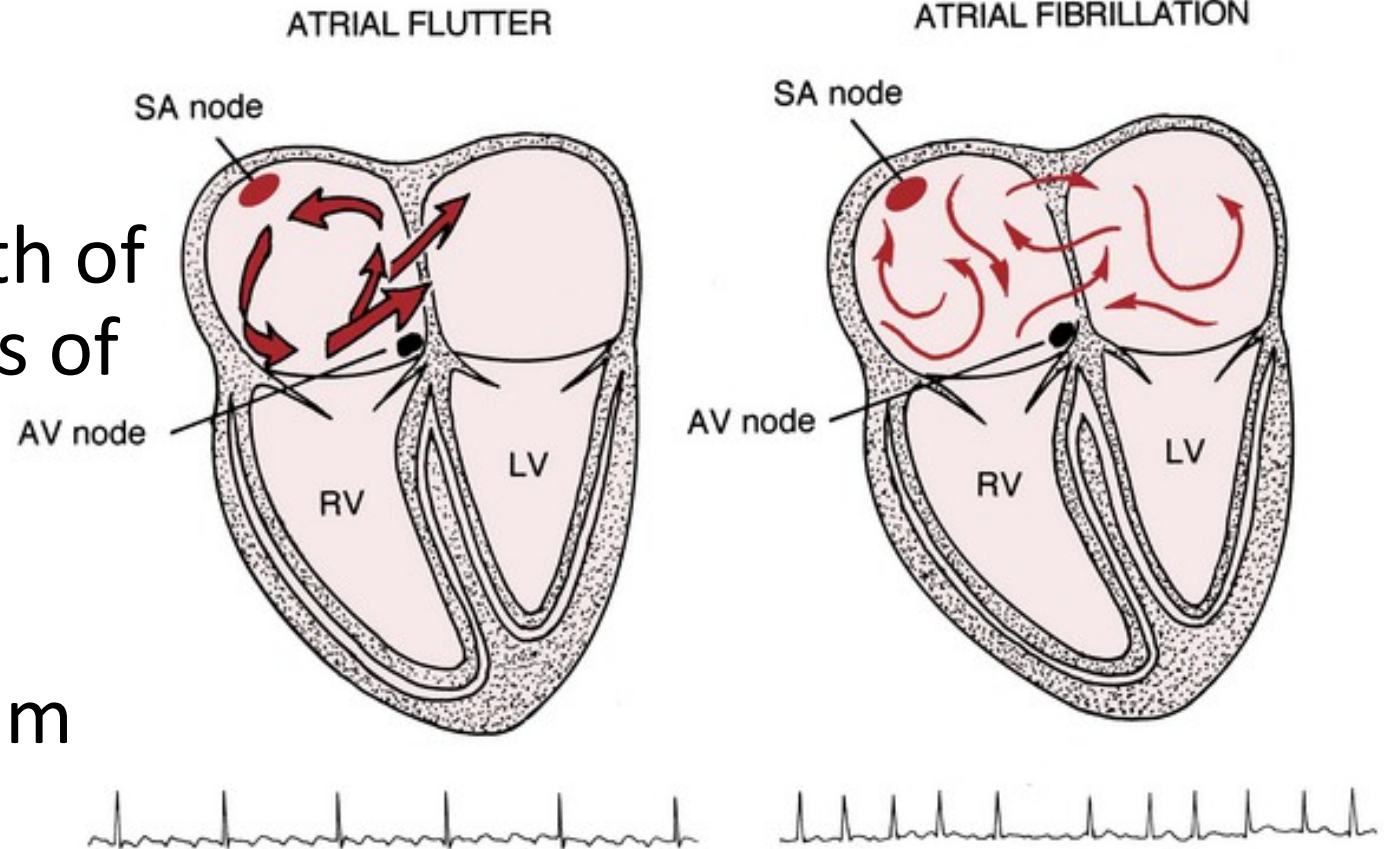
Atrial fibrillation with slow ventricular response



Module 3

Atrial flutter

- Rapid atrial conduction
- Circus movement
 - Continuous self-perpetuating circular path of excitation around orifices of SVC & IVC
- Focal movement
 - Ectopic focus in the atrium discharging rapidly
 - AVN cannot conduct every impulse

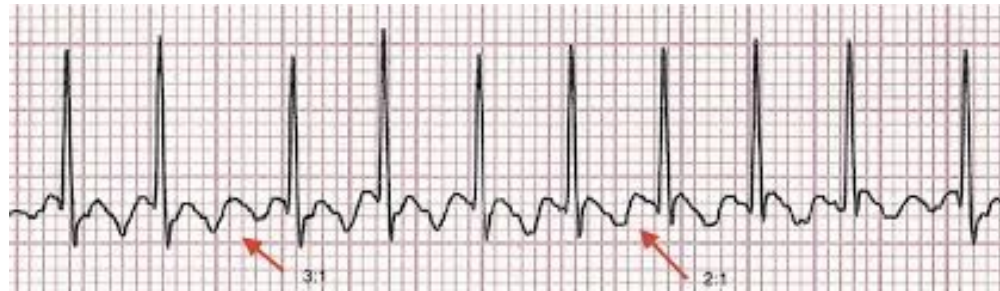


Saw – tooth Flutter Waves

- P wave – Rapid (300-350bpm) , bizarre but regular seen in a pattern
- Ventricular Rhythm – more likely regular due to AVN conduction ability. But can have variable block
- QRS – normal (without any IVCD)



3:1 block

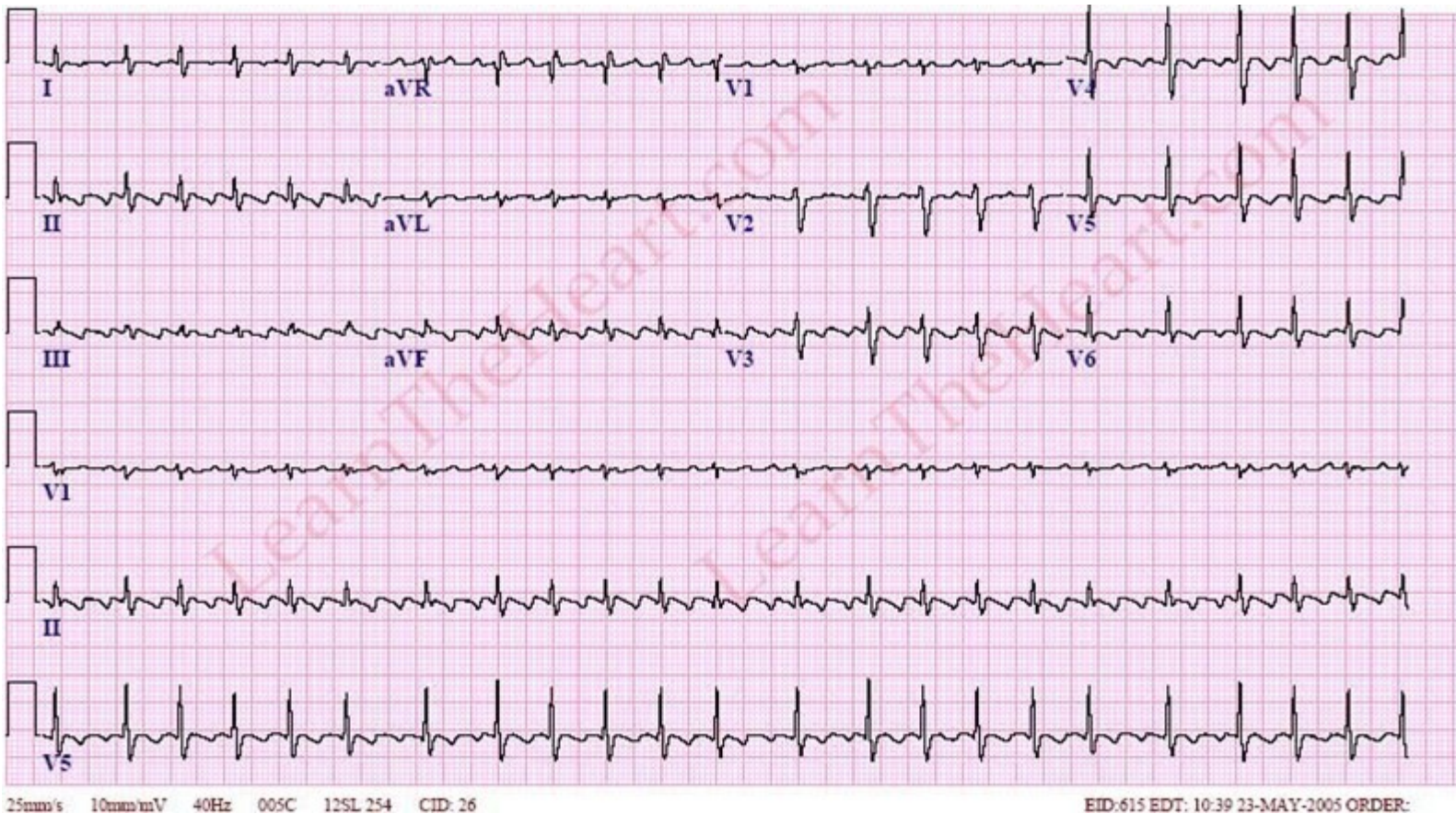


2:1block



variable
block

Atrial flutter – variable block

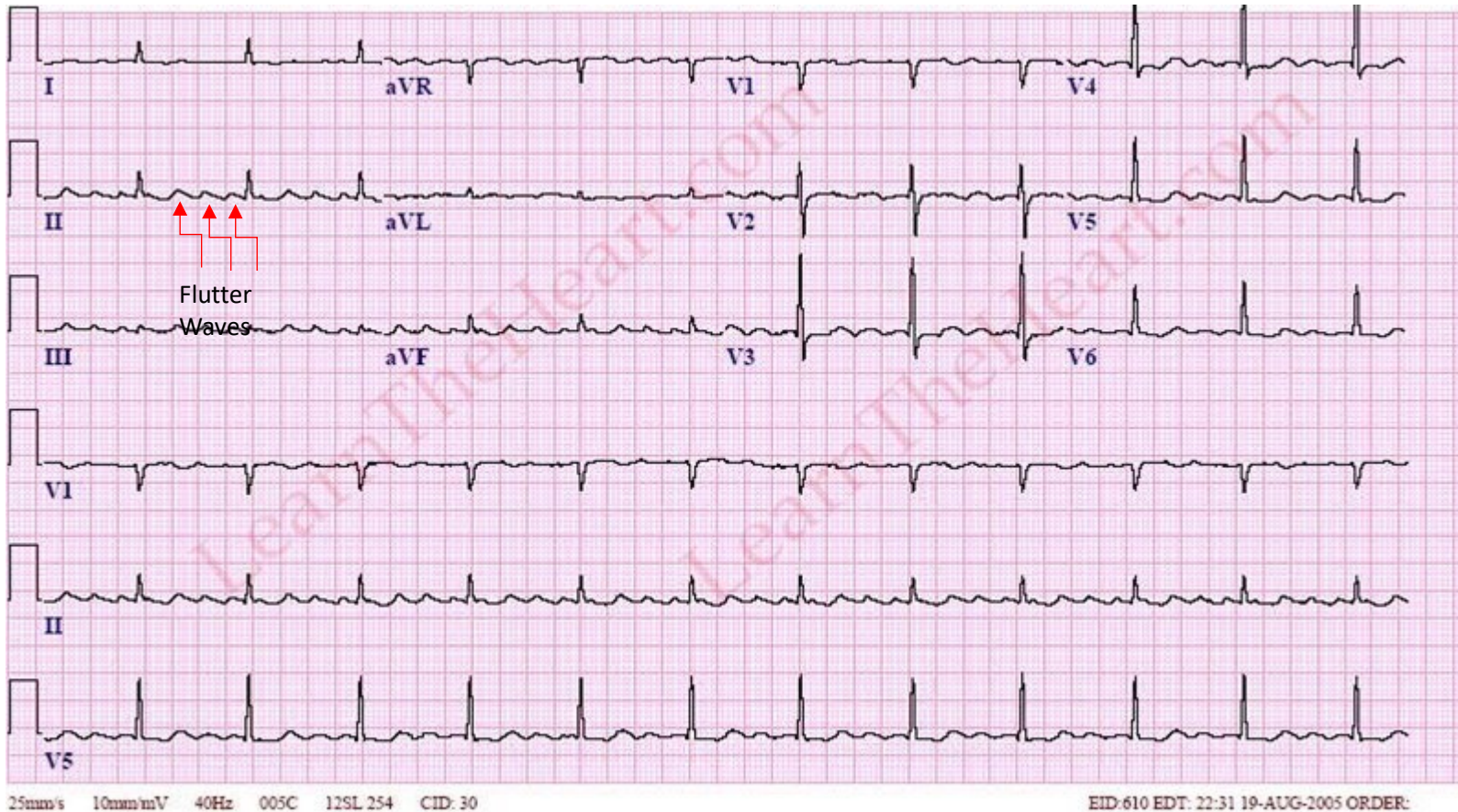


No clear definable P waves

“saw-tooth “ flutter waves

RR mostly regular with occasional variation

Atrial flutter 3:1 block



No clear definable P waves

“saw-tooth “ flutter waves
3 flutter waves to 1 QRS

RR mostly regular with
occasional variation

Module 4: Supraventricular Tachycardia

SVT

SVT

- Narrow complex tachycardia
- Focus above ventricles
- Cycle can be shorter than refractory period
- Some atrial impulses are blocked (normally 2:1 or 3:1)
- Going so fast (>150bpm) P waves cannot be identified

Sudden onset / Sudden offset

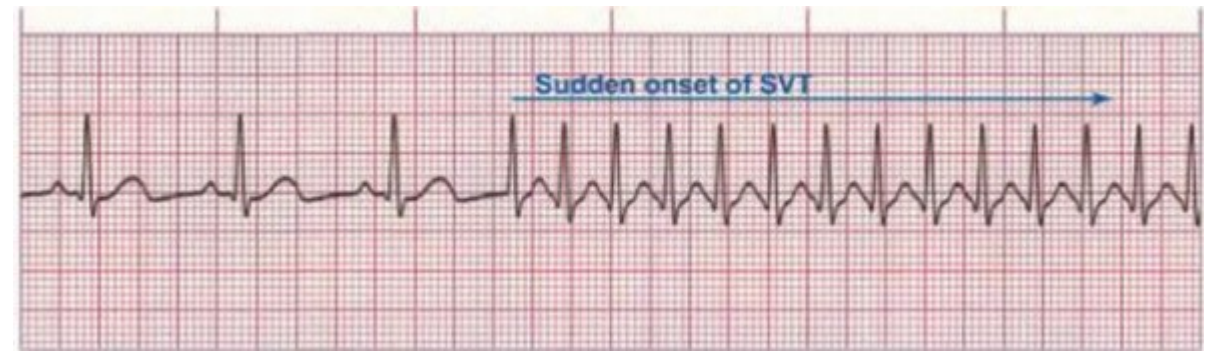
Non visible P waves

Regular RR interval

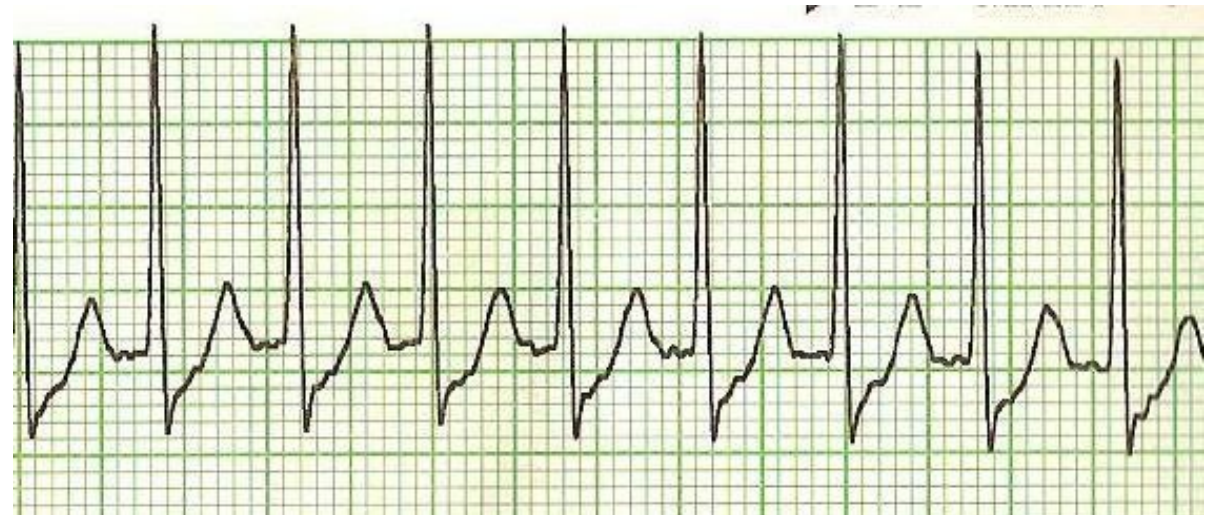
Narrow QRS

>150BPM

Often due to accessory pathway



May cause
rate related
Ischaemia



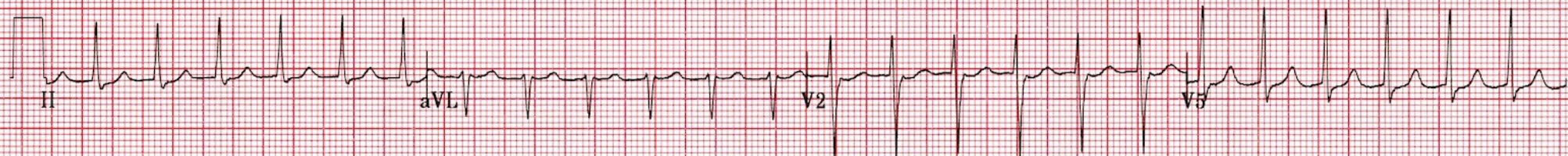


No P waves visible

QRS normal / narrow

RR regular

HR 150BPM

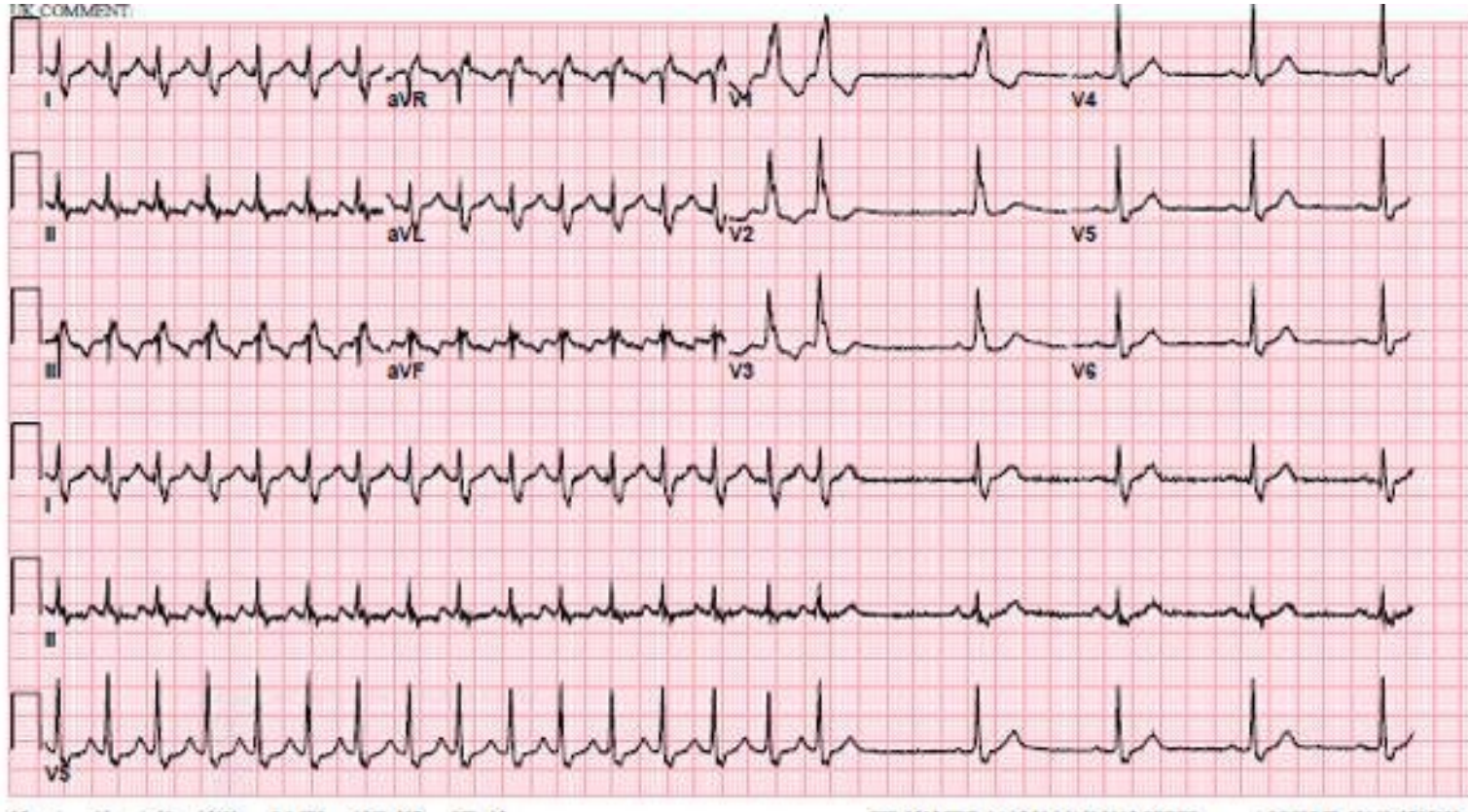


150 Hz 25.0 mm/s 10.0 mm/mV

4 by 2.5s + 1 rhythm ld

MAC35 009B.1

12SL™ v239



SVT returning to Sinus rhythm

Initial ECG (SVT)

No P waves visible

QRS normal / narrow

RR regular

HR 150BPM

Post SVT

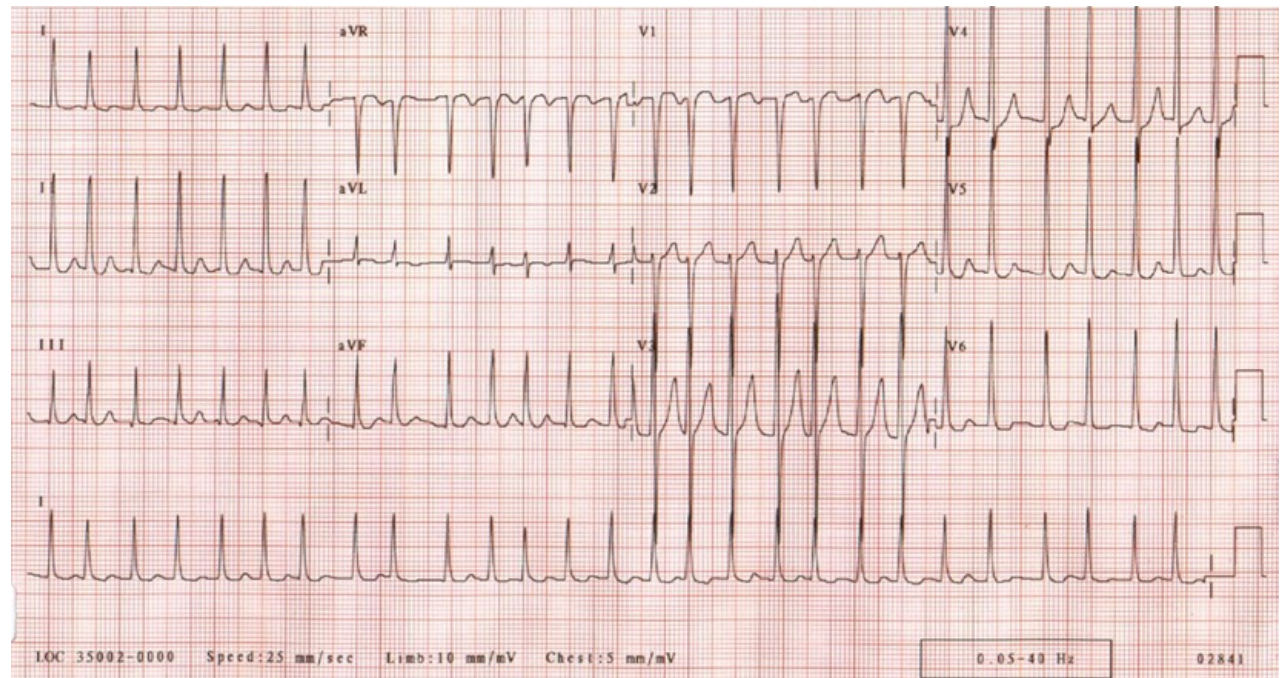
Sudden offset

1 P wave to 1 QRS

RR regular

Sinus rhythm

Difference between Fast AF and SVT

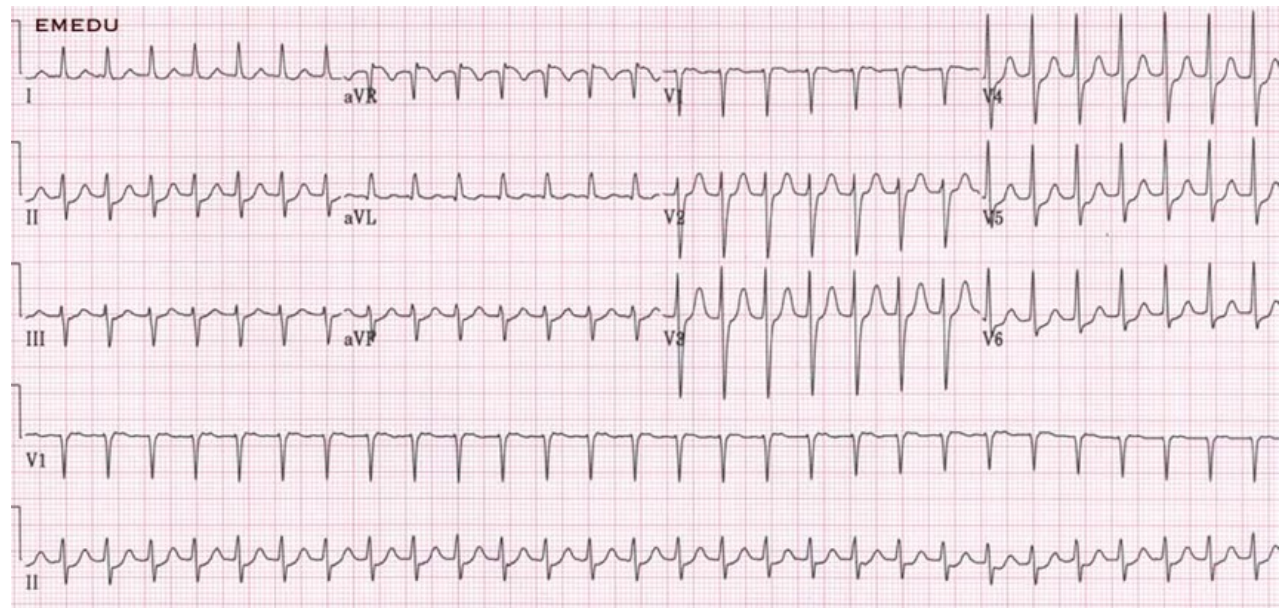


Fast AF
(Irregular)

RR Interval

Variable in Fast AF

Regular in SVT



SVT
Regular