ECG Basics - A ECG right-sided chest leads

Right Ventricular Wall Infarction

Right-sided ECG lead placement

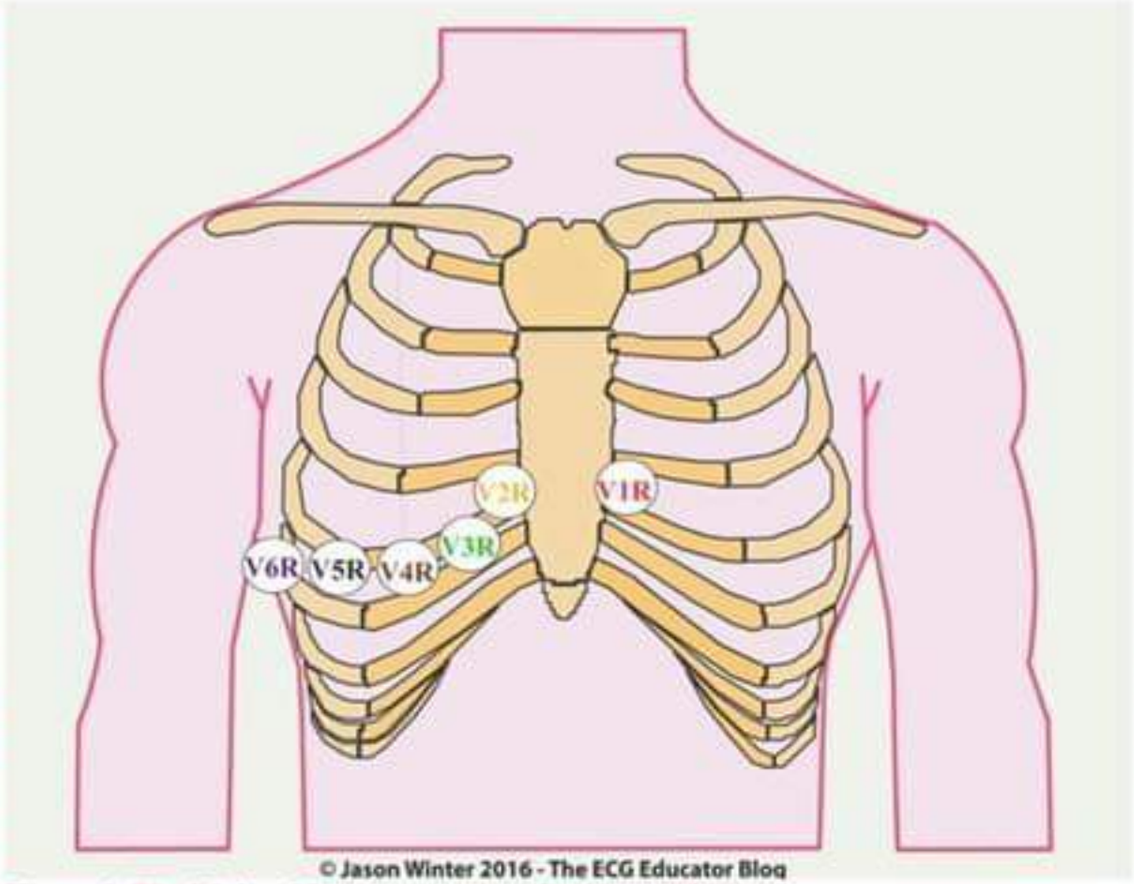


Figure 1 - The Right-sided correct positioning of ECG leads

Always double check your lead placement to confirmed your in the correct anatomical spaces.

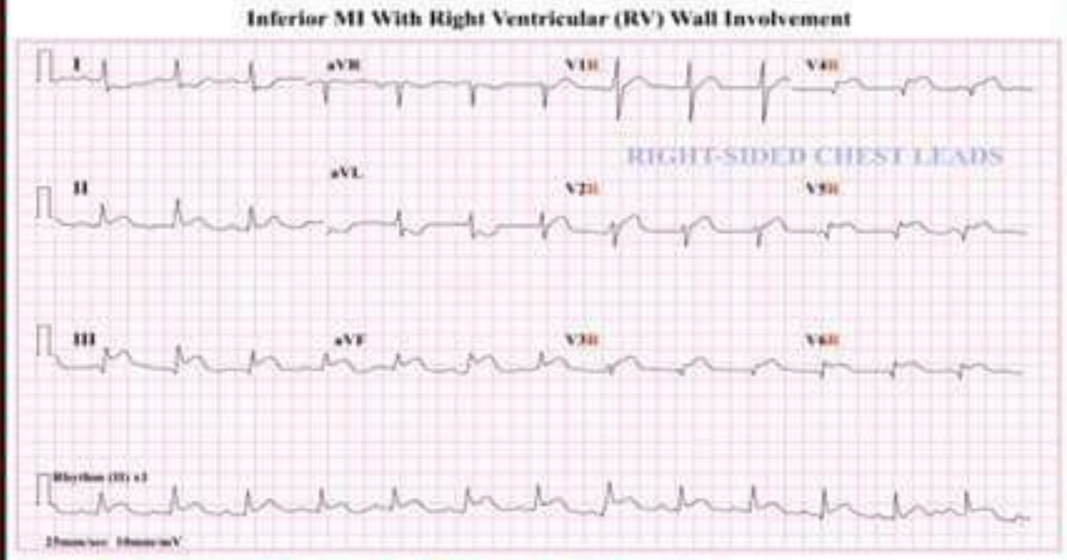


Figure 2 - Correct labeling of the Right-sided ECG

A complete set of right-sided leads is obtained by placing leads V1-6 in a mirror-image position on the right side of the chest (see Fig-1 diagram).

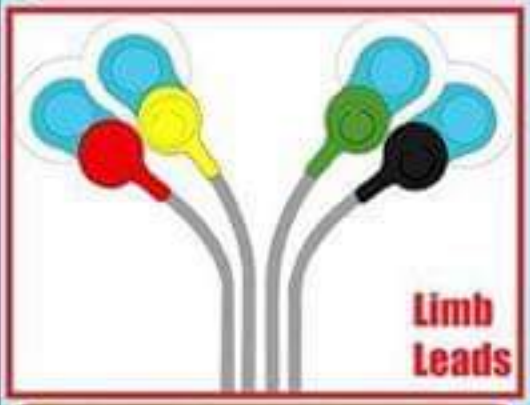
It may be simpler to leave V1 and V2 in their usual positions and just transfer leads V3-6 to the right side of the chest (i.e. V3R to V6R).

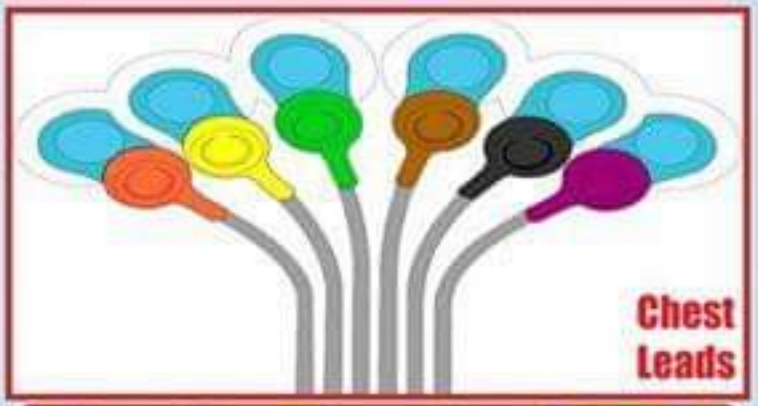
*The most useful lead is V4R

25mm/sec 10mm/mV

ECG Leads Colour Coding Standards USA/Europe

IEC (International Electrotechnical Commission)

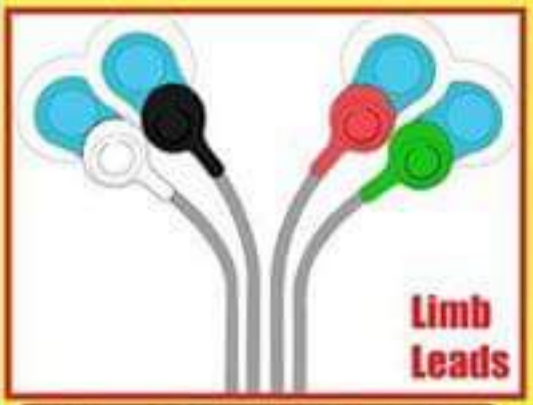


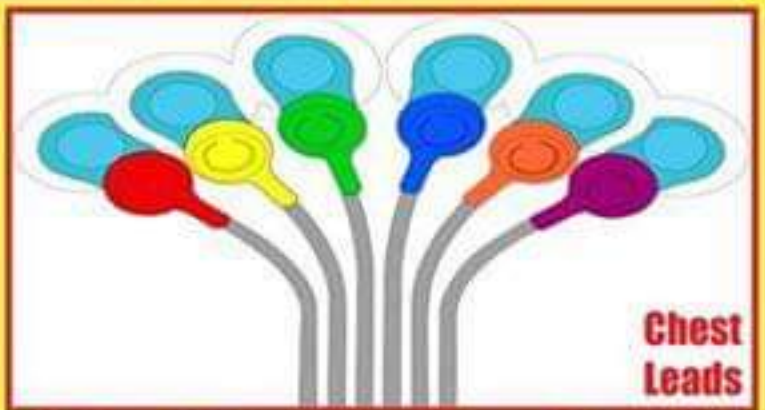


I	II	III	N
Red	Yellow	Green	Black
Right Arm (RA)	Left Arm (LA)	Left Leg (LL)	Right Leg (RL)

V1 C1	V2 C2	V3 C3	V4 C4	V5 C5	V6 C6
Red/ White	Yellow/ White	Green/ White	Brown/ White	Black/ White	Violet/ White

AHA (American Heart Association)



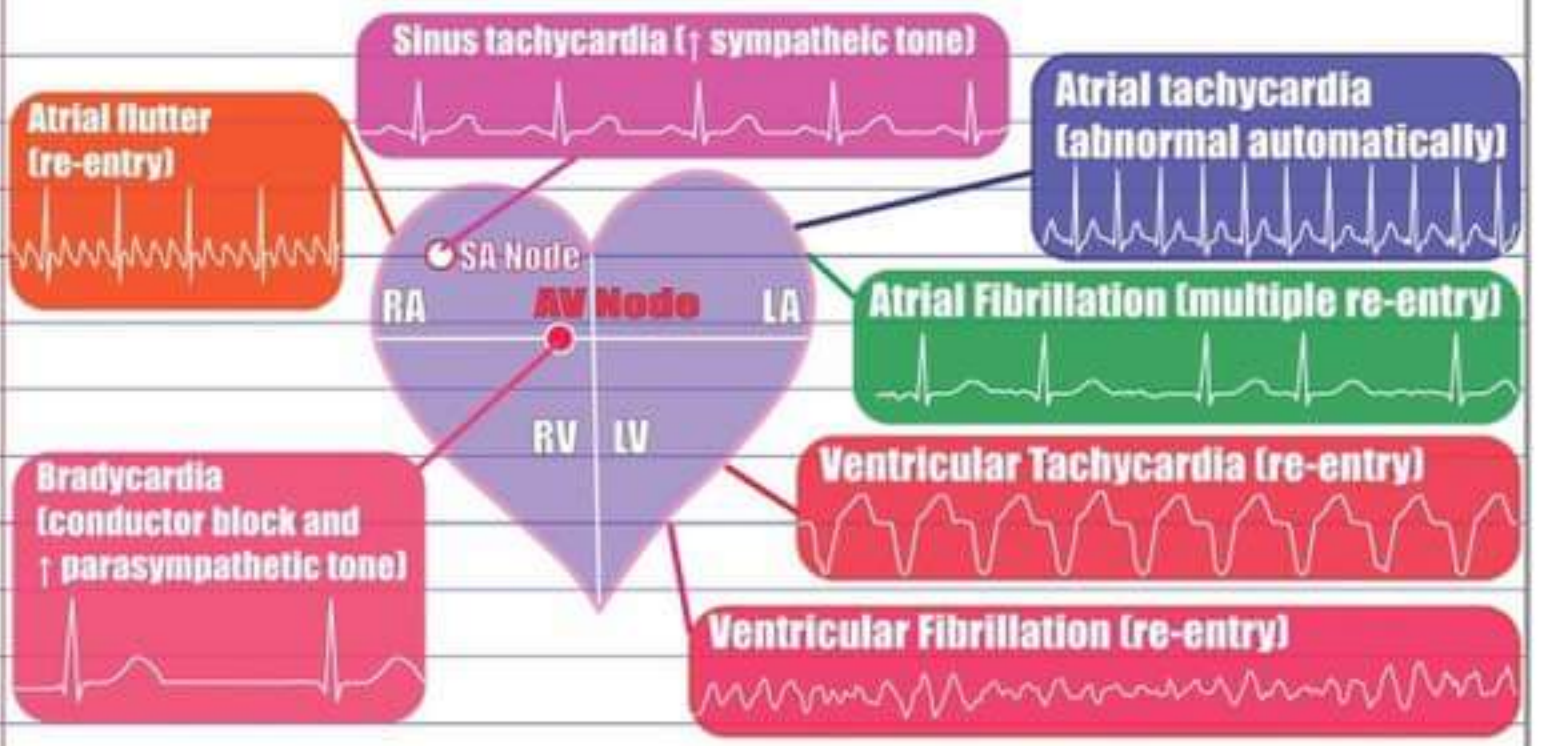


I	II	III	N
White	Black	Red	Green
Right Arm (RA)	Left Arm (LA)	Left Leg (LL)	Right Leg (RL)

V1 C1	V2 C2	V3 C3	V4 C4	V5 C5	V6 C6
Red/ Brown	Yellow/ Brown	Green/ Brown	Blue/ Brown	Orange/ Brown	Purple/ Brown

Management of Arrhythmias

This diagram below shows the origin of some common arrhythmias.



* Treatment is decided based on the underlying reason for the arrhythmia. A brief guide below.

Vaughan Williams classification

Myocardial Problem (re-entry) → **Class I drugs: Block Na+ channels and depress conduction of action potentials**

Arrhythmia

Class II drugs: Beta blockers which ↓ abnormal automatically by ↓ sympathetic stimulation

Nodal problem ↑ sympathetic

Class III drugs: Block K+ channels and ↓ SAN automatically

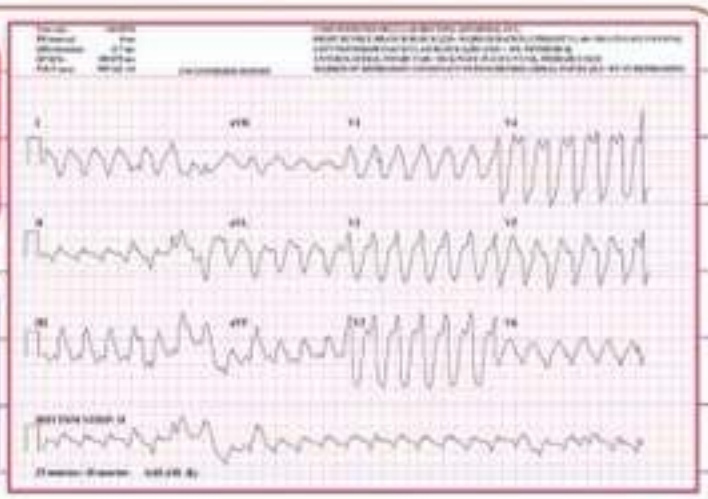
Class IV drugs: Block Ca2+ channels and ↓conduction in AVN therefore slows ventricular rate

* Many attempts have been made to classify antiarrhythmic agents. The problem arises from the fact that many of the antiarrhythmic agents have multiple modes of action, making any classification imprecise

Ventricular Tachycardia (VT) Signs

Signs of Ventricular Tachycardia

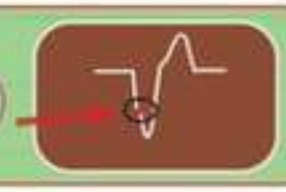
Very broad complexes (>160ms)



A fusion beat - Dressler beat occurs when sinus and ventricular electrical impulses coincides at the same time to produce a hybrid complex/beat. If it acts upon the ventricular chambers it is called a ventricular fusion beat.

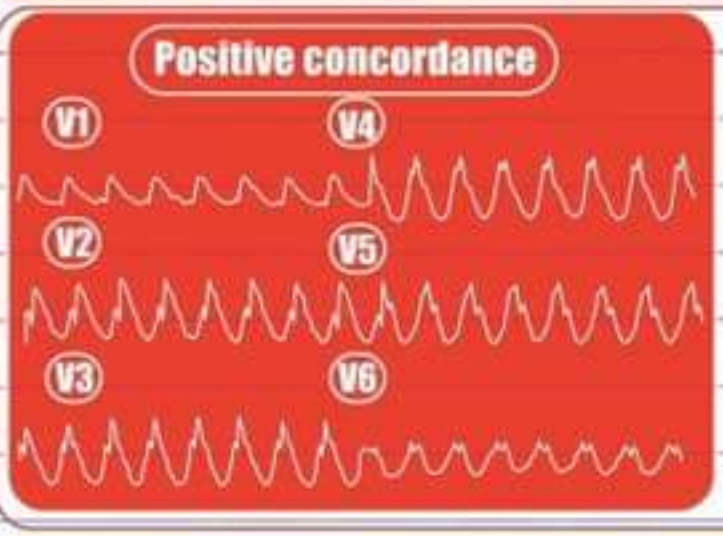
A capture beat occurs from the production of a ventricular complex by a supraventricular source in the cardiac cycle after atrioventricular (AV) dissociation, for the atria to regain control of the ventricles.

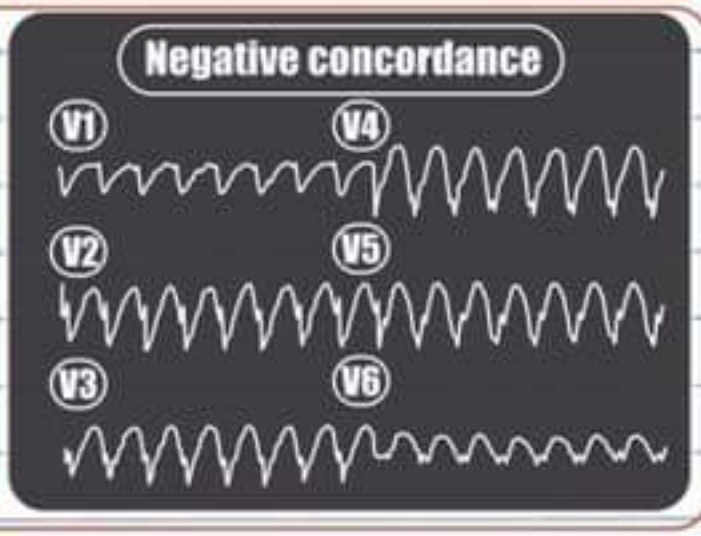
Josephson's sign – Notching near the nadir of the S-wave.



Brugada's sign – Is the distance from the onset of the QRS complex to the nadir of the S-wave is >100ms.

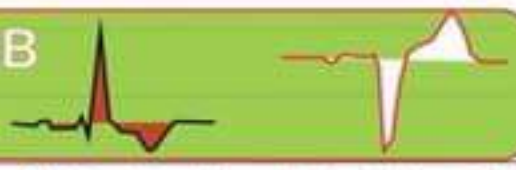
Extreme axis deviation ("northwest axis") — QRS is positive in aVR and negative in I + aVF





AV dissociation (P and QRS complexes at different rates).

Absence of typical RBBB or LBBB morphology.

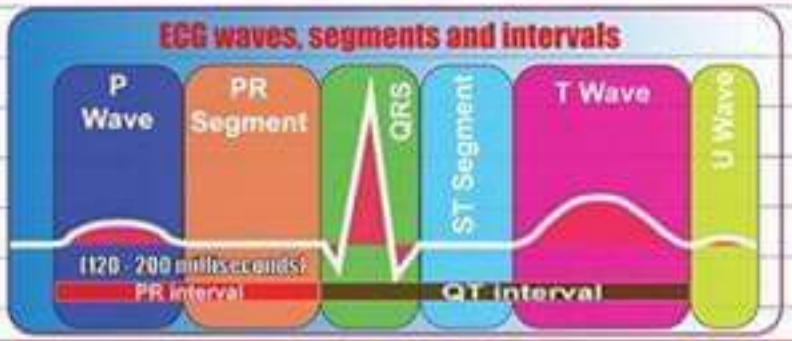


Introduction To Heart Blocks

Which type of AV block is it?

Miss P Wavey

ECG waves, segments and intervals

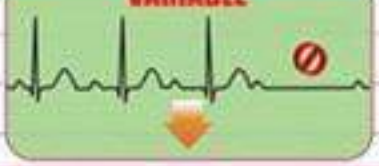


Evaluate 'PR' Interval

Miss PR

CONSTANT (PRI >0.2 secs)

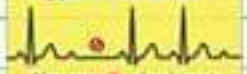
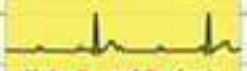
VARIABLE



Evaluate 'P' QRS RATIO

Common ratio: 2:1, 3:1 and 4:1

Evaluate 'RR' Interval

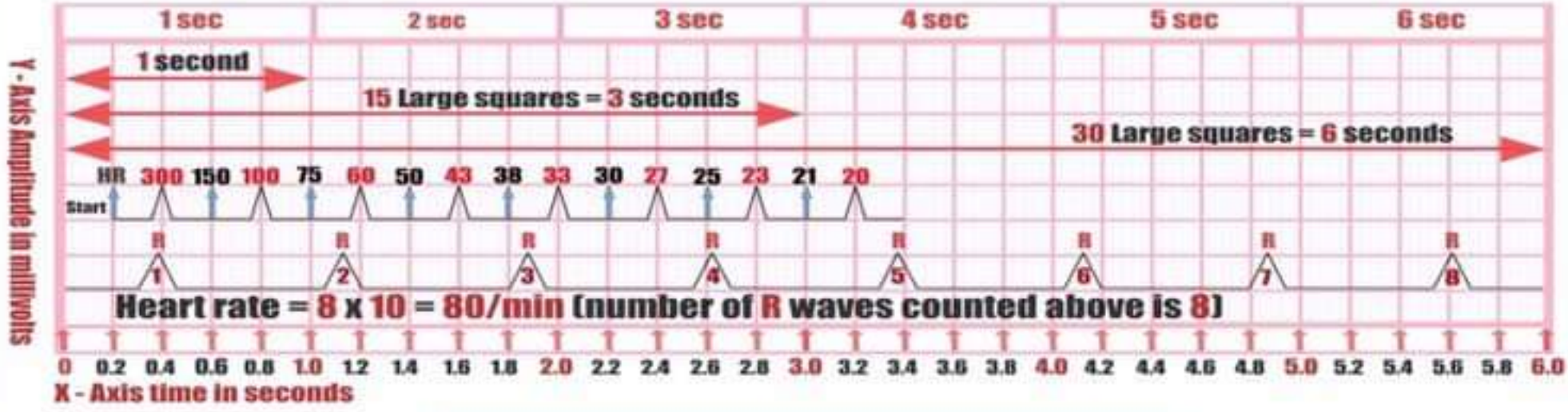
1 'P' per QRS	>1 'P' per QRS	VARIABLE	CONSTANT
↓	↓	↓	↓
1st Degree	**2nd Degree Type 2 (Mobitz)**	**2nd Degree Type 1 (Wenckebach)**	**3rd Degree**
			
If the R is far from P, then you have a FIRST DEGREE	If some Ps don't get through, then you have MOBITZ II	Longer, longer, longer drop! Then you have a WENCKEBACH	If the Ps and Qs don't agree, then you have a THIRD DEGREE

How to try to remember these AV blocks

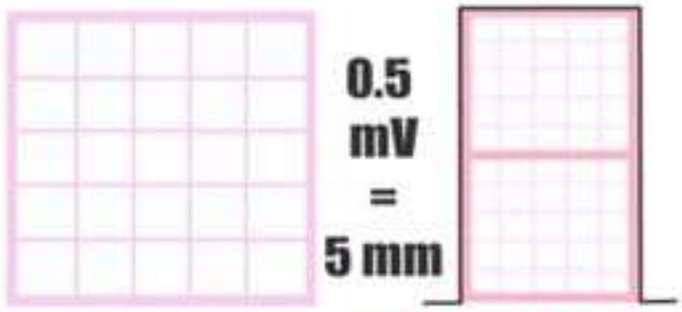
Mr QRS

1st Degree	2nd Degree Type 2 (Mobitz)	2nd Degree Type 1 (Wenckebach)	3rd Degree
All P waves conduct	More P waves then QRS complexes	More P waves then QRS complexes	More P waves then QRS complexes
PRI constant >0.20 secs	PR interval is constant	PR interval gets longer and longer	No PRI: P to P constant
All present ✓	QRS dropped periodically	QRS dropped periodically	QRS to QRS constant

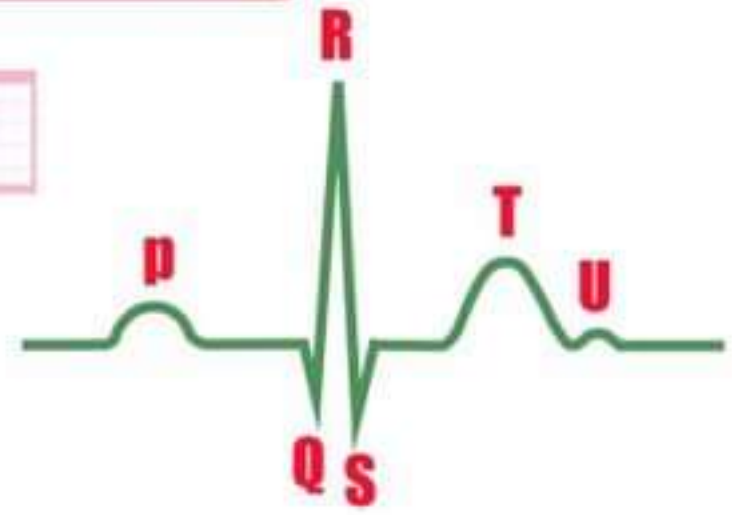
ECG Interpretation Reference



Large block method for heart rate calculation



1mm (small square) = 0.04 sec or 0.1 mV
5mm (big square) = 0.2 sec or 0.5 mV



Measuring the QTc - Bazett's - Corrected QTc

$$QTc = \frac{QT\ (msec)}{\sqrt{RR\ (secs)}}$$

Step 1. Measure the QT in milliseconds
Step 2. Measure the R-R interval in seconds
Step 3. Get the Square root of the R-R interval

$$\text{Bazett's Formula: } QTc = \frac{QT\ interval}{\sqrt{RR\ (Seconds)}}$$

- The QT shortens at faster rates and lenthens at slower rates
- The corrected QT interval (QTc) estimates the QT interval at a heart rate of 60 bpm, this allows comparison of QT values over time at different heart rates and improves detection of arrhythmias.

*Abnormally long and short QT intervals have been shown to be associated with an risk for life-threatening ventricular arrhythmia and sudden cardiac death.

Posterior Wall Myocardial Infarction

Posterior Wall ECG Lead Placement

Posterior ECG lead placement

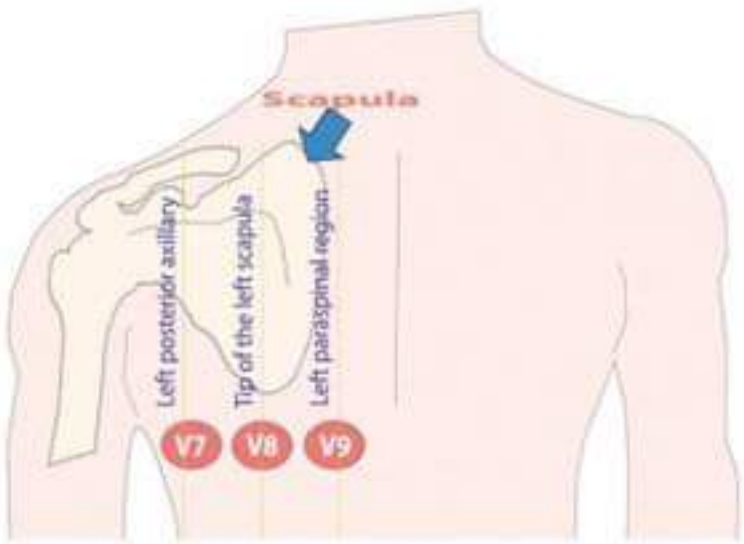


Figure 1 - Shows correct positioning of posterior leads

Posterior MI is suggestive by the following changes in V1-V3:

*Horizontal ST depression
*Tall, broad R waves (>30ms)
*Upright T waves
*Dominant R wave (R/S ratio >1) in V2

V1-V3 Should remain unchanged from standard 12-lead ECG

V7

Left posterior axillary line: in the same horizontal plane as V4-V6

V4 becomes V7

V8

Tip of the left midscapula: in the same horizonal plane as V7-V9

V5 becomes V8

V9

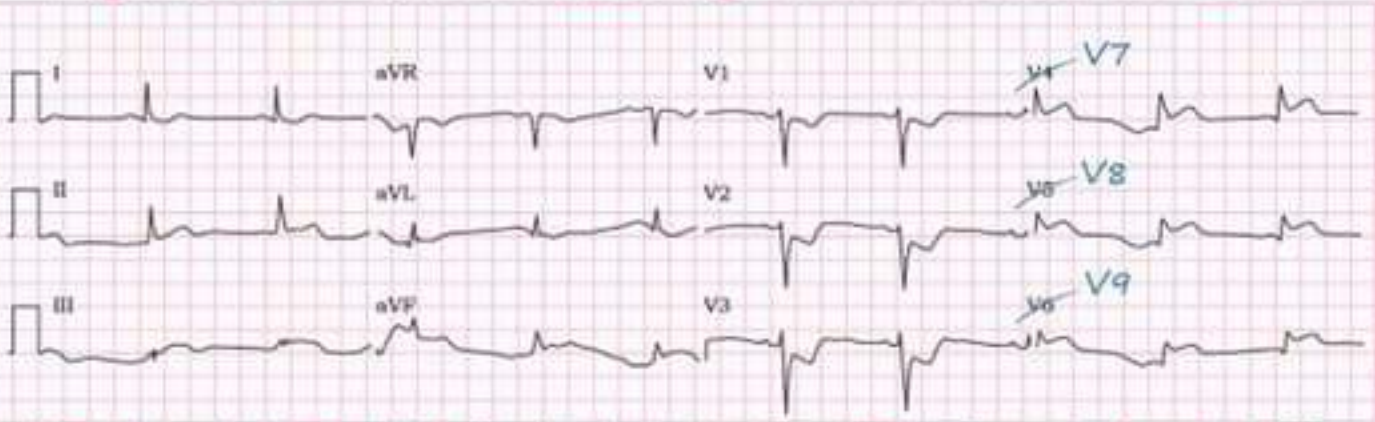
Left paraspinal region: in the same horizonal plane as V4-V6

V6 becomes V9

Please note that V6 is a good reference point for the horizontal placement of the posterior electrobes V7-9.

If you don't have access to to a 15 or 18 lead ECG machine, then leave V1-3 in their normal position and use V4-6, these leads will then become V7-9.

Figure 2 - Correct labeling of the Posterior ECG



*Note that only 0.5 mm of ST elevation is required to make the diagnosis of posterior MI

Brugada Syndrome

First described by Spanish cardiologists the Brugada brothers in 1992 by Dr. Pedro Brugada, Ramon and Josep Brugada.

Brugada syndrome is an hereditary disease that is associated with high risk of sudden cardiac death. It is characterized by typical ECG abnormalities: RBBB type ST segment elevation in the precordial leads (V1 - V3).

Brugada syndrome have been shown to be associated with mutations in the SCN5A gene that encodes for a sodium ion channel in the cell membranes of the muscle cells of the heart (the myocytes); this is often referred to as a sodium channelopathy.

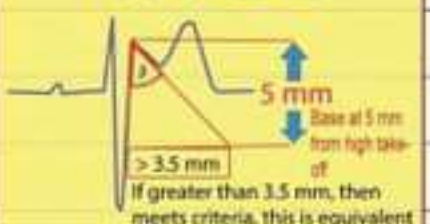
ECG pattern in Brugada syndrome. type 1 ST segment elevation, either spontaneously present or induced with the sodium channel-blocker challenge test, is considered diagnostic. Type 2 and 3 may lead to suspicion, but the drug challenge is required for diagnosis.

Brugada syndrome has three different ECG patterns:

TYPE 1

Coved type STE

TYPE 2



Saddle - back type STE

TYPE 3

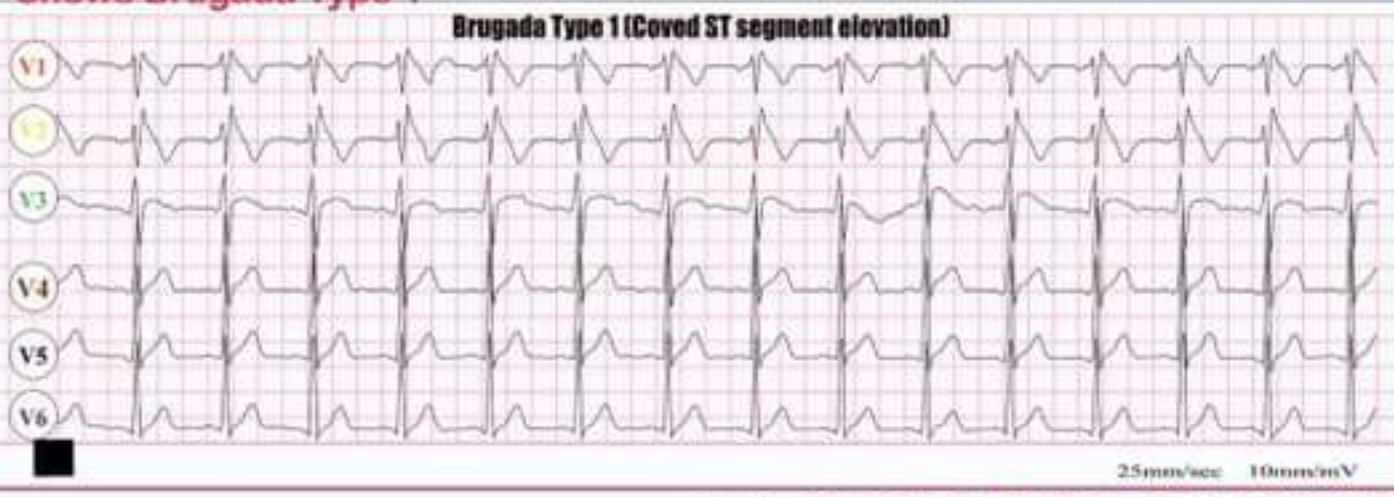
Saddle - back type STE

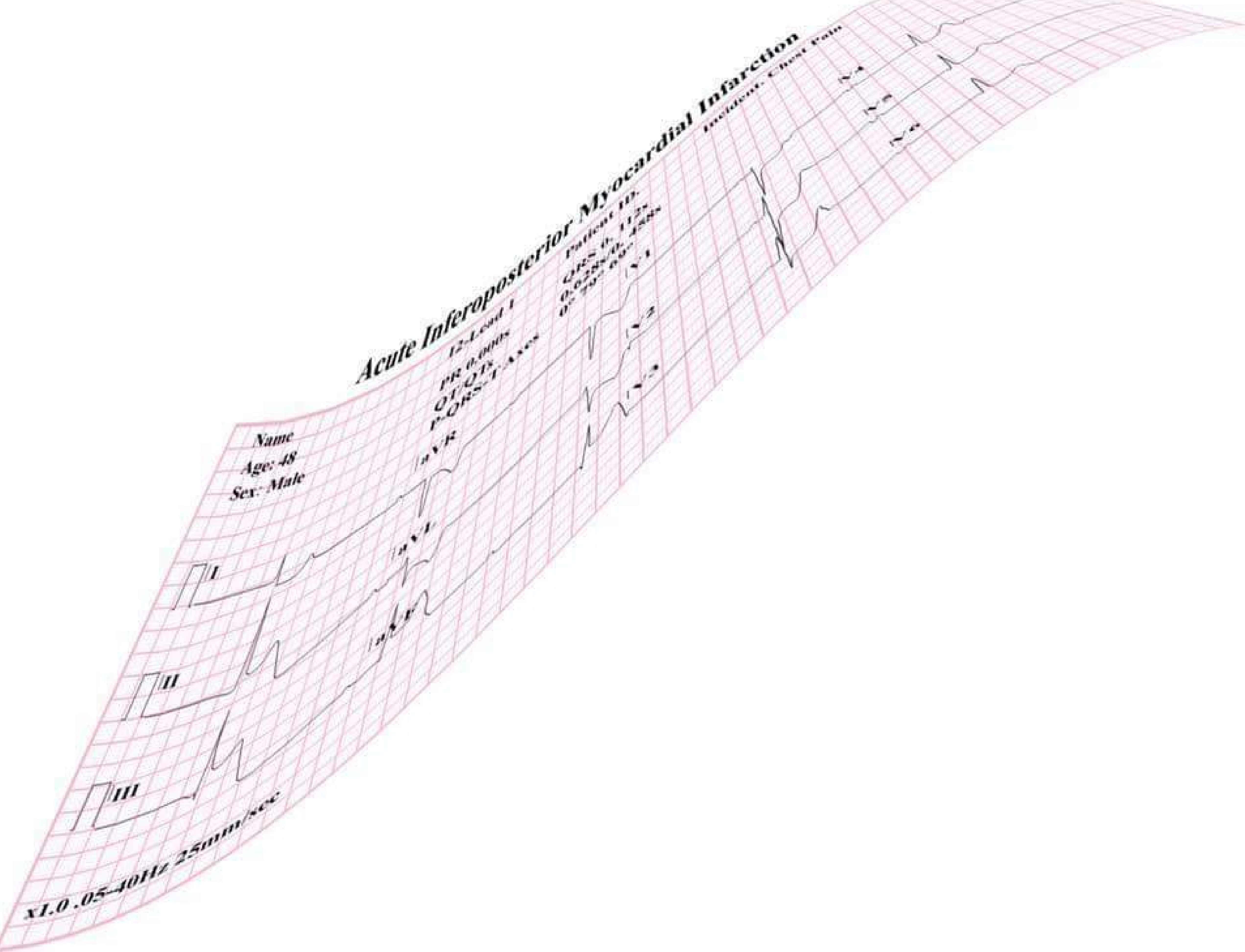
Type 1 has a coved type ST elevation with at least 2 mm (0.2 mV) J-point elevation and a gradually descending ST segment followed by a negative T-wave.

Type 2 has a saddle-back pattern with a least 2 mm J-point elevation and at least 1 mm ST elevation with a positive or biphasic T-wave. Type 2 pattern can occasionally be seenin healthy subjects.

Type 3 has either a coved (type 1 like) or a saddle-back (type 2 like) pattern, with less than 2 mm J-point elevation and less than 1 mm ST elevation. Type 3 pattern is not rare in healthy subjects.

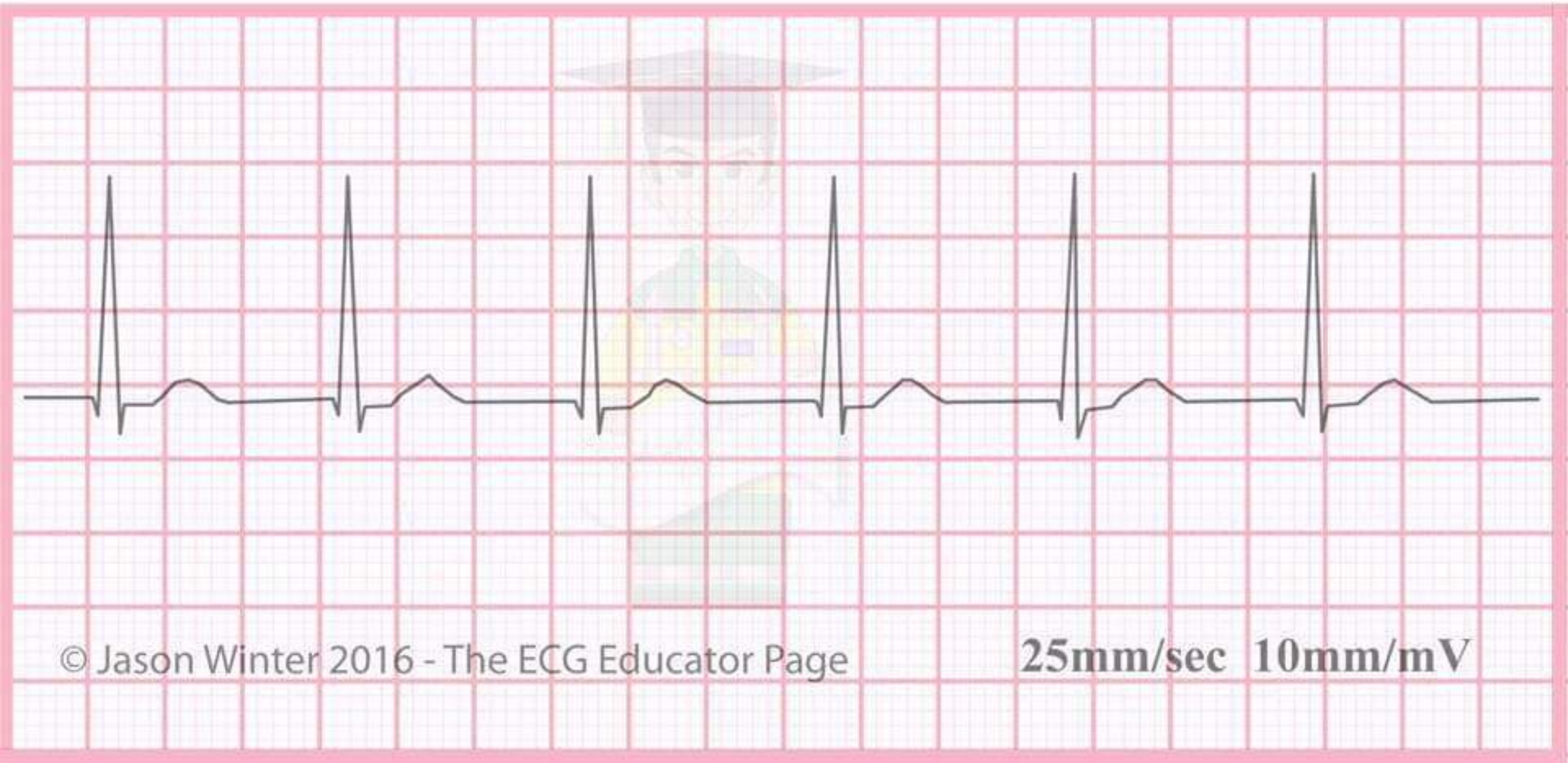
Shows Brugada Type 1





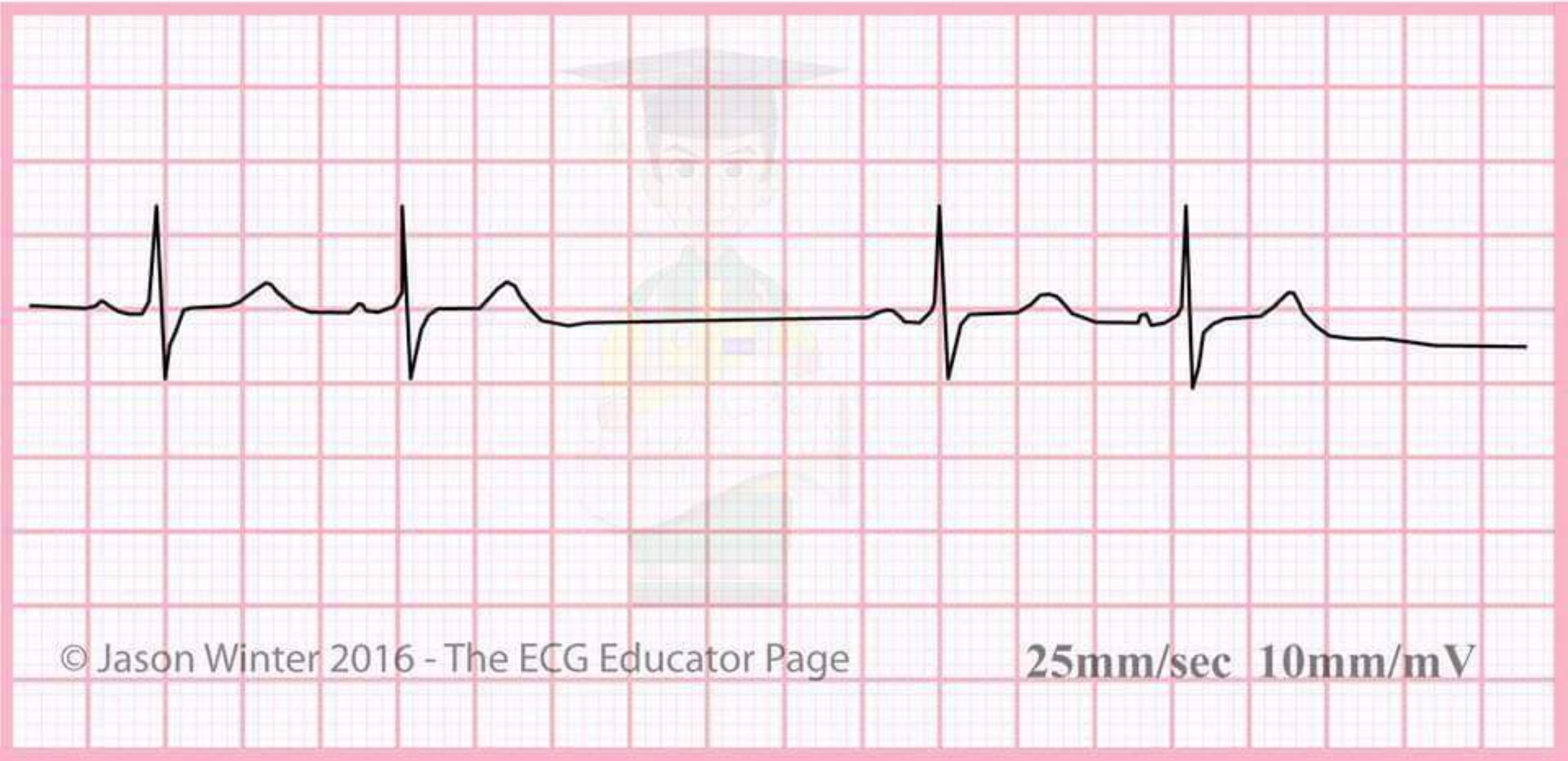
Acute Inferoposterior Myocardial Infarction
12-Lead 1
Patient ID.
Incident: Chest Pain
PR
QRS
QT/QTc
P-QRS-T Axes
Name
Age: 48
Sex: Male
I
II
III
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
x1.0 .05-40Hz 25mm/sec

Accelerated Junctional Rhythm

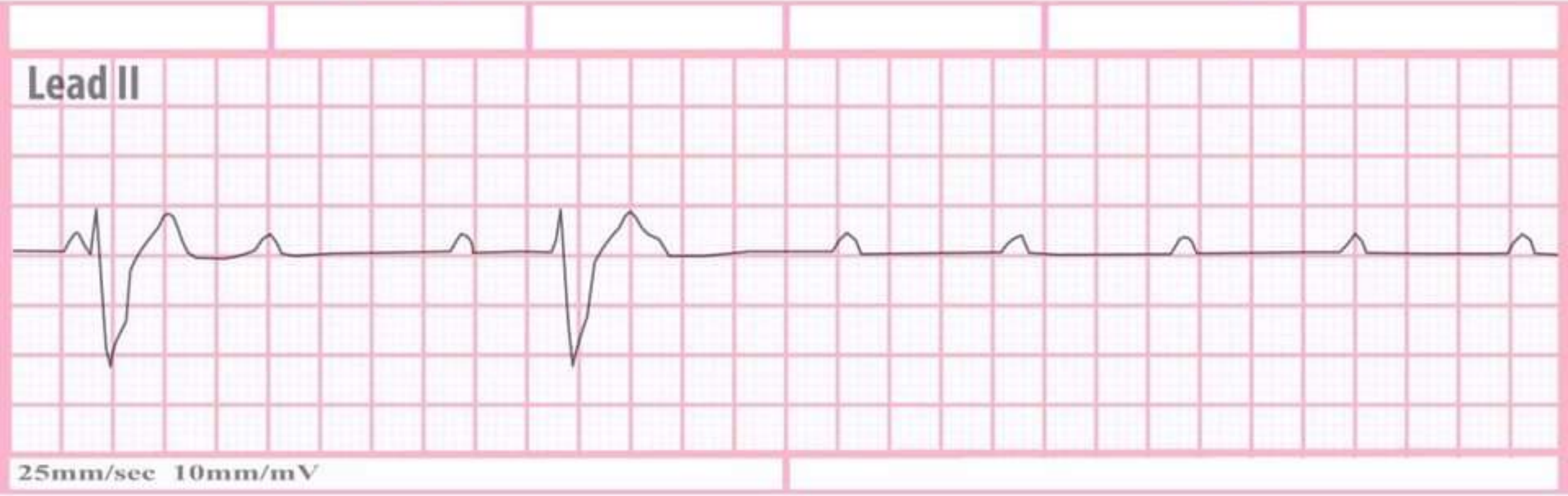


Premature Junctional Complex (PJC)

Atrial Bigeminy



Complete heart block with ventricular escape rhythm changing to ventricular standstill rhythm




Lead II
25mm/sec 10mm/mV
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Sinoatrial Node Rhythms

Normal Sinus Rhythm

Rhythm Regular **P Wave** Before QRS

PR interval 0.12-0.20s **QRS** <0.12

Sinus Bradycardia

Rhythm Regular **P Wave** Before QRS

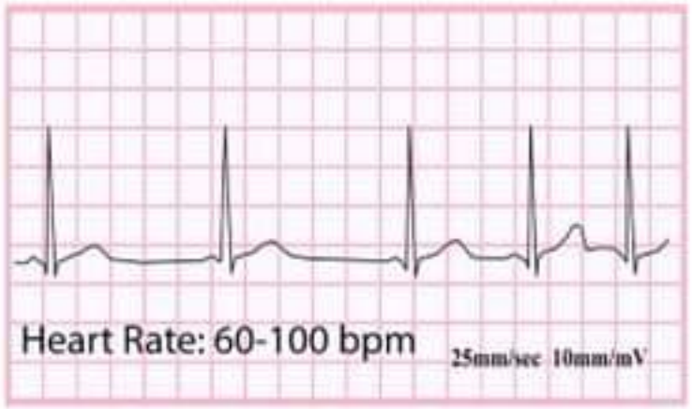
PR interval 0.12-0.20s **QRS** <0.12

Sinus Tachycardia

Rhythm Regular **P Wave** Before QRS

PR interval 0.12-0.20s **QRS** <0.12

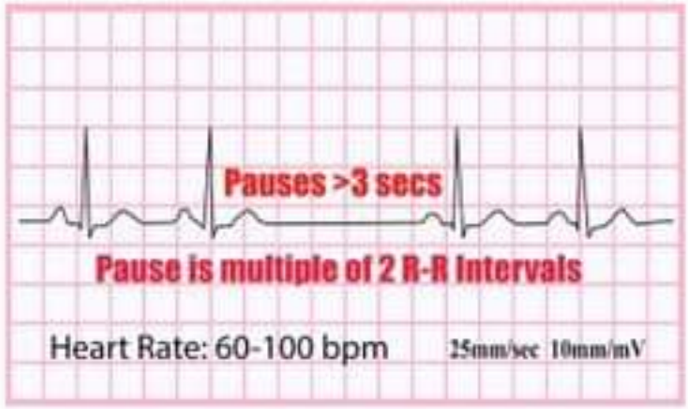
Sinus Arrhythmia



Rhythm Irregular **P Wave** Before QRS

PR interval 0.12-0.20s **QRS** <0.12

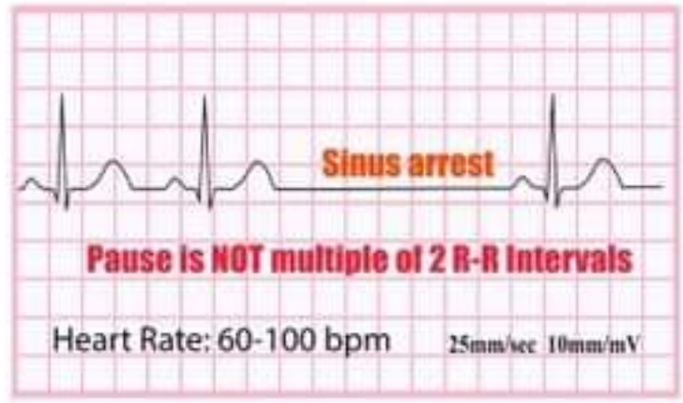
Sinoatrial Exit Block



Rhythm Irregular **P Wave** Before QRS

PR interval 0.12-0.20s **QRS** <0.12

Sinus Pause



Rhythm Irregular **P Wave** Before QRS

PR interval 0.12-0.20s **QRS** <0.12

Atrial Rhythms

Atrial Fibrillation

Rhythm: Irregular
PR interval N/A
P Wave: Fibrillatory Waves
QRS: <0.12

Atrial Flutter

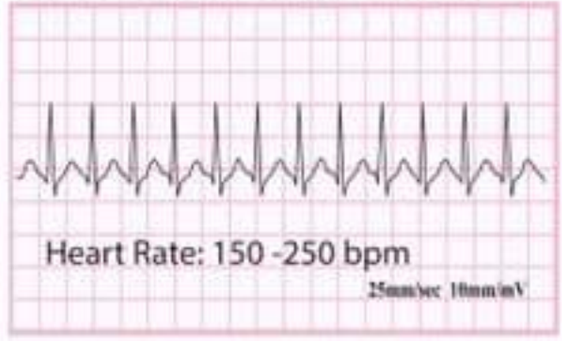
Types 2:1, 3:1, 4:1, or greater ratio (1:1) conduction is rare

Rhythm: Regular or variable
PR interval N/A
P Wave: Flutter waves
QRS: <0.12

Atrial Bigeminy

Rhythm: Irregular
PR interval: 0.12- 0.20s
P Wave: Premature or hidden
QRS: <0.12

Supraventricular Tachycardia (SVT)



Rhythm: Regular
PR interval: Not always possible to measure
P Wave: Often buried in the T waves
QRS: <0.12

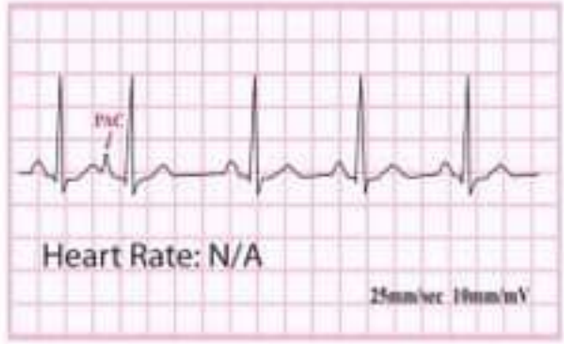
Wondering Atrial Pacemaker

Rhythm: Irregular
PR interval: 0.12- 0.20s
P Wave: 3 types or more different P wave morphologies
QRS <0.12

Multifocal Atrial Tachycardia (MAT)

Rhythm: Irregular
PR interval: Variable
P Wave: 3 types or more different P wave morphologies
QRS: <0.12

Premature Atrial Contraction (PAC)



Rhythm: Irregular
PR interval: 0.12- 0.20s
P Wave: Premature (abnormal) or hidden
QRS: <0.12

Wolff-Parkinson White (WPW)

Rhythm: Regular w/o A-fib
PR interval Short <0.12
P Wave: Normal unless A-fib
QRS: >0.10 with delta wave

Junctional Rhythms

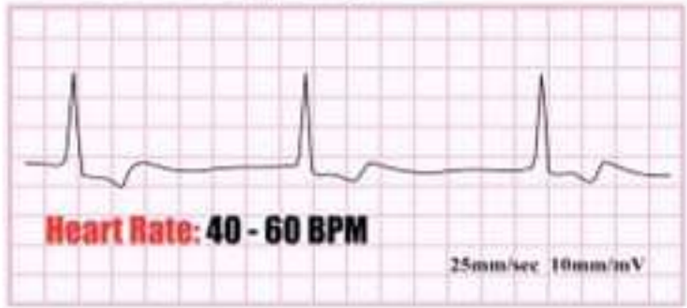
Junctional Rhythm with no P-waves

Rhythm: Regular
PR interval: 0.12-0.20s
P Wave: Absent or after QRS
QRS: <0.10

Junctional Rhythm with retrograde P-waves

Rhythm: Regular
PR interval: 0.12-0.20s
P Wave: Inverted before QRS
QRS: <0.10

Junctional Escape Rhythm



Rhythm: Regular
PR interval: 0.12-0.20s
P Wave: Absent, hidden, inverted or after QRS
QRS: <0.10

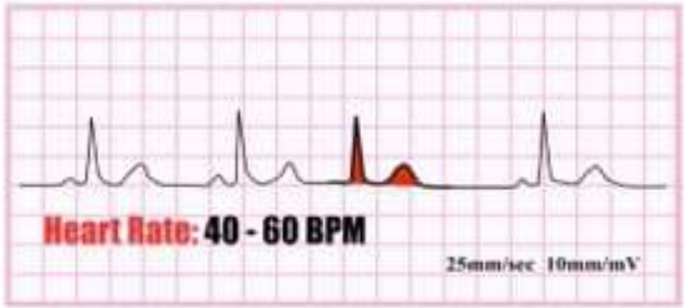
Accelerated Junctional Rhythm

Rhythm: Regular
PR interval: 0.12-0.20s
P Wave: Absent, hidden, inverted or after QRS
QRS: <0.10

Junctional Tachycardia

Rhythm: Regular
PR interval: Not measurable
P Wave: Absent, hidden, inverted or after QRS
QRS: <0.10

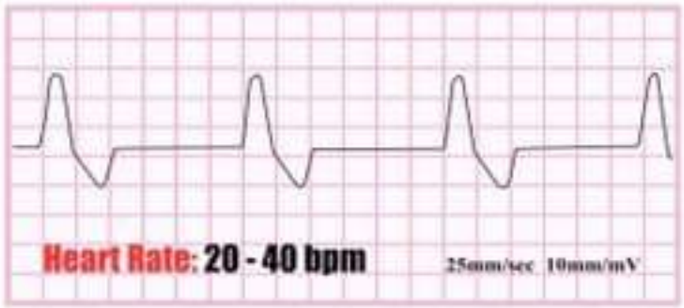
Premature Junctional Complex (PJC)



Rhythm: Regular with premature beats
PR interval: 0.12-0.20s
P Wave: Absent, hidden, inverted or after QRS
QRS: <0.10

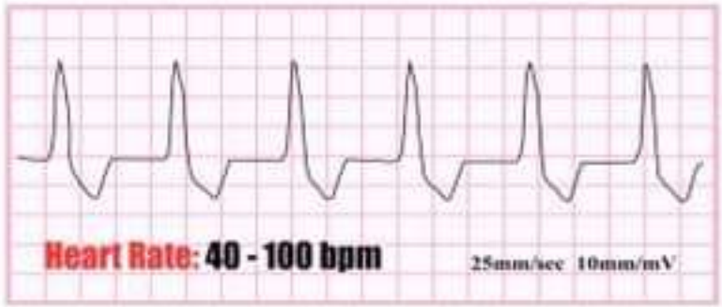
Ventricular Rhythms

Idioventricular Rhythm



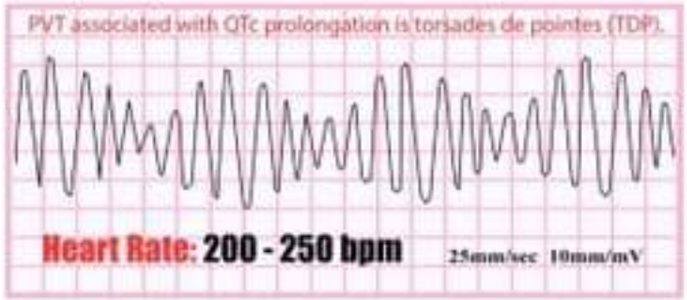
Rhythm: Regular
PR interval: N/A
P Wave: Absent or not related
QRS: Wide >0.12, atypical

Accelerated Idioventricular Rhythm



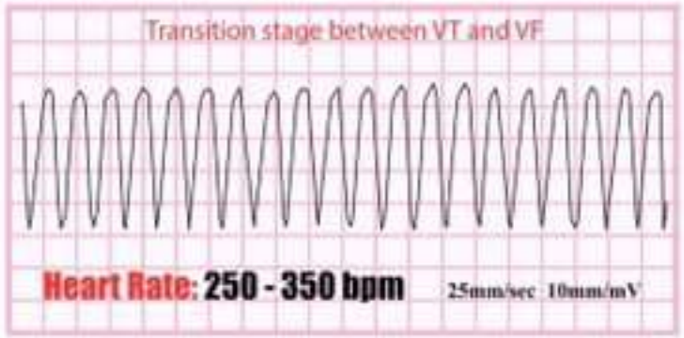
Rhythm: Regular
PR interval: N/A
P Wave: Absent or not related
QRS: >0.12

Polymorphic Ventricular Tachycardia



Rhythm: Irregular
PR interval: N/A
P Wave: Absent
QRS: Wide bizarre appearance

Ventricular Flutter

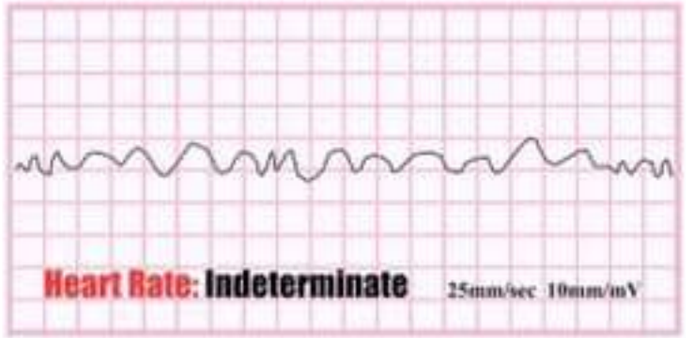


Rhythm: Regular
PR interval: Not measurable
P Wave: Absent
QRS: >0.12 Sinusoidal waveforms

Ventricular Tachycardia

Rhythm: Regular
PR interval: Not measurable
P Wave: Dissociated atrial rate
QRS: Wide >0.12, atypical

Ventricular Fibrillation



Rhythm: Chaotic fibrillatory activity
PR interval: N/A
P Wave: Absent
QRS: Fibrillatory baseline

Ventricular Ectopics

NSR with isolated PVC

FROM A SINGLE ECTOPIC FOCI

Multifocal PVCs

FROM MULTIPLE ECTOPIC FOCI

NSR with Ventricular Couplets

TWO CONSECUTIVE PVCs

Ventricular Triplets (Salvo)

3 CONSECUTIVE PVCs IN A ROW

Ventricular Bigeminy

EVERY OTHER BEAT IS A PVC

Ventricular Trigeminy

EVERY THIRD BEAT IS A PVC

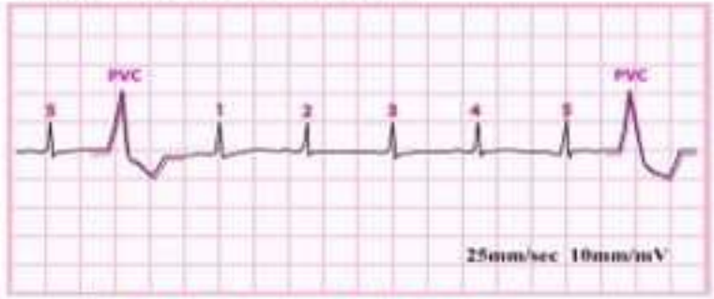
Ventricular Quadrigeminy

EVERY FOURTH BEAT IS A PVC

Ventricular Pentageminy

EVERY FIFTH BEAT IS A PVC

Ventricular Hexageminy



EVERY SIXTH BEAT IS A PVC

Heart Blocks

First Degree AV Block

Rhythm: Regular
PR interval: Prolonged >0.20 sec
P Wave: Normal
QRS: <0.12

Second Degree AV Block - Type 1 (aka Mobitz 1, Wenckebach):

Rhythm: Irregular
PR interval: Increasingly Prolonged
P Wave: Normal
QRS: <0.12

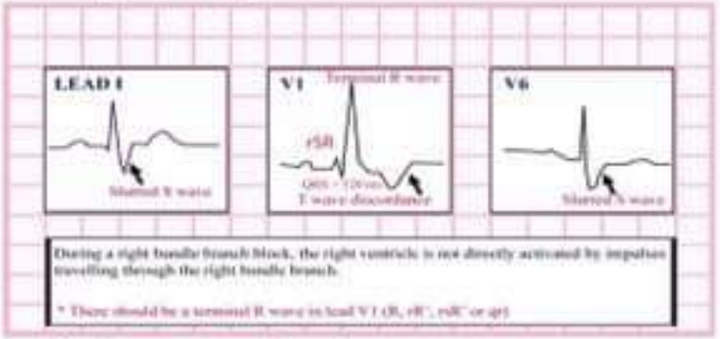
Second Degree AV Block - Mobitz Type 2

Rhythm: Irregular
PR interval: Normal (more P waves then QRS)
P Wave: Normal
QRS: Usually wide >0.10

3rd Degree AV Block

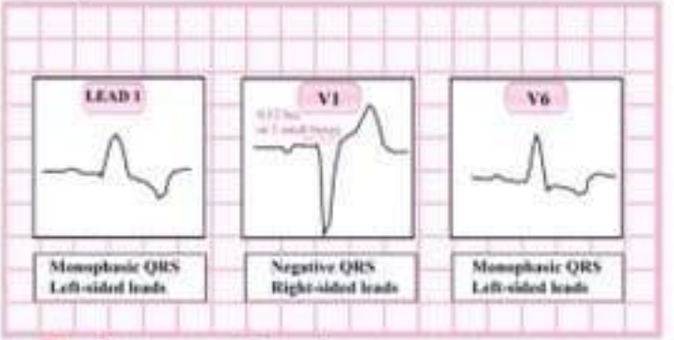
Rhythm: Regular
PR interval: None
P Wave: Normal does not relate to QRS
QRS: Normal or wide

Complete Right Bundle Branch Block



Rhythm: Regular
PR interval: Normal
P Wave: Normal
QRS: Wide >0.12

Complete Left Bundle Branch Block



Rhythm: Regular
PR interval: Normal
P Wave: Normal
QRS: Wide >0.12

ECG Basics - A ECG right-sided chest leads

Right Ventricular Wall Infarction

Right-sided ECG lead placement

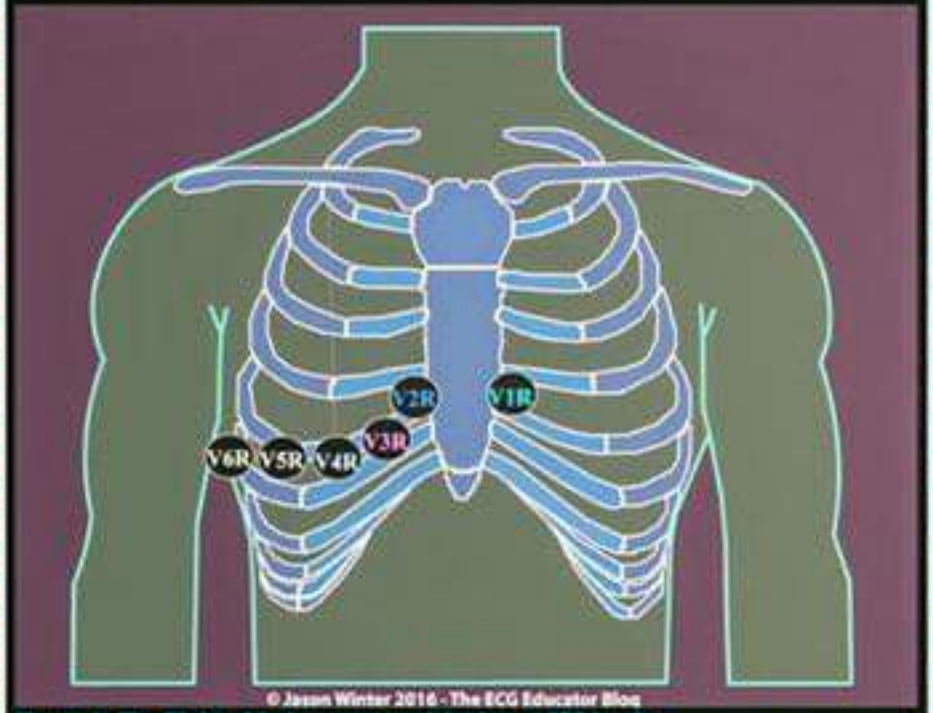


Figure 1 - The Right-sided correct positioning of ECG leads

Always double check your lead placement to confirmed your in the correct anatomical spaces.

Figure 2 - Correct labeling of the Right-sided ECG

A complete set of right-sided leads is obtained by placing leads V1-6 in a mirror-image position on the right side of the chest (see Fig-1 diagram).

It may be simpler to leave V1 and V2 in their usual positions and just transfer leads V3-6 to the right side of the chest (i.e. V3R to V6R).

***The most useful lead is V4R**

25mm/sec, 10mm/mV