Physiology lab 2 summary

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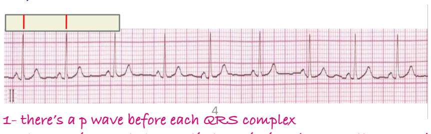
1 small square = 1 mm
1 large square (5 small squares) = 5 mm
Horizontally (seconds): 1 small square = 0.04 seconds
1 large square = 0.2 seconds
Vertically (mv): 1 small square = 0.1 mv
10 large squares = 1 mv

- to check for the presence of the sinus rhythm : 1-check the presence of a p wave before every QRS complex and the p wave should have the same contour in the same lead 2- the R-R interval should have a little variation: less than 3 small squares (<0.12 seconds)

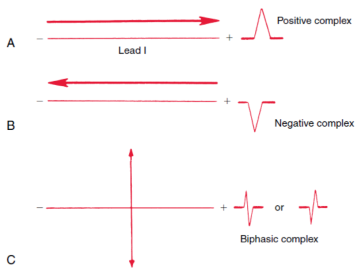


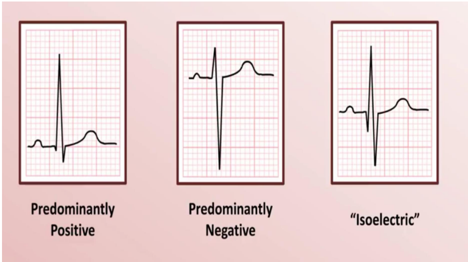
1- there's a p wave before each QRS complex
2- the R-R intervals have a little variation (<3 small squares)

-Heart Rate : normal heart rate ranges between 60-100
There are 3 different ways for calculating the heart rate : 1- heart rate = 60/ R-R interval
2- heart rate = 300/#large squares in the R-R interval
3- heart rate = 1500/#small squares in the R-R interval
The 6 second method : count the number of the QRS complexes in 6 seconds then multiply the answer by 10 .
6 seconds = 30 large squares

Heart rate = 9 (#large squares) x 10 = 90 BPM

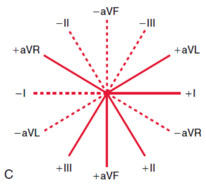
Vectorial analysis of ECG : -the arrow head is in the positive direction -
- the length of the arrow is drawn proportional to the voltage of the potential
- in a normal ventricular depolarization the current flows form the base toward the apex (downwards not upwards)
-mean QRS vector = +59

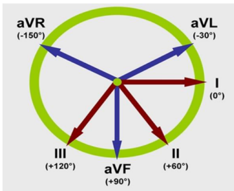




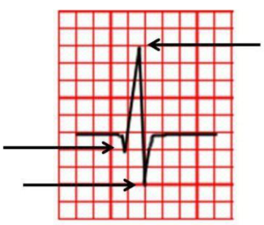
-Deteremining the cardiac axis : -normal cardiac axis can swing between -30 degrees to +90
- variations could occur due to differences in the purkinjie distribution system , age , body built
-also some pathological conditions can lead to axis deviation

Lead 1 and aVF are perpendicular to each other
Lead 2 and aVL are perpendicular to each other
Lead 3 and aVR are perpendicular to each other



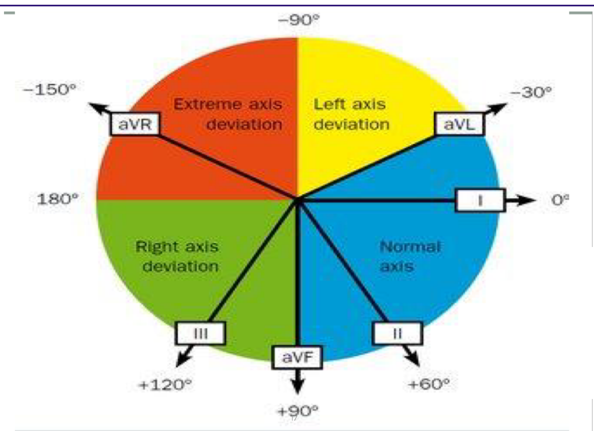


- calculating the net potential (deflection) : positive part - negative part
-calculating the voltage of the QRS complex : it's measured from the peak of the R wave to the bottom of the s Or Q wave



Net deflection (potential) = 0.5 - 0.3 - 0.1 = +0.1 mv

Voltage of the QRS complex = 0.8 mv



Quadrant method

Lead I	Lead aVF	AXIS
Positive	Positive	Normal
Positive	Negative	Left Axis Deviation or Normal
Negative	Positive	Right Axis Deviation
Negative	Negative	Extreme Axis Deviation (marked left or right axis)

To further distinguish normal from left axis deviation When Lead I is positive & Lead aVF is negative we look at lead II. If lead II negative, then the cardiac axis is more towards -120, and left axis deviation is present. If the QRS complex in lead II is positive, then the cardiac axis is more towards +60 degrees, and the cardiac axis is normal.

In the example above both lead I and aVF are positive so the axis is normal

The Isoelectric lead method

1. Find the isoelectric lead; it has zero net amplitude. This can be either:
   - A biphasic QRS where R wave height = Q or S wave depth.
   - A flat-line QRS with no discernible features.

2. Look for the lead perpendicular to the isoelectric lead. If the QRS complex in this lead is predominantly positive, the cardiac axis will be located in its direction; if the QRS is predominantly negative, the cardiac axis will be located on the opposite direction

In the above example, the most isoelectric lead is aVL. Lead II is perpendicular to it. Lead II is positive so the cardiac axis must be in its direction which is 60 degrees. So the axis is normal.

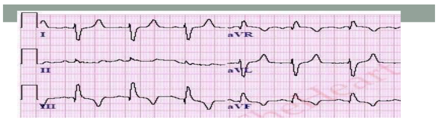
Mathematical method

- Calculating the Axis:

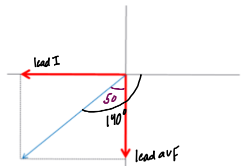
1. Record the bipolar and augmented limb leads
2. Determine the net potential and polarity of the recordings in leads I and aVF.
3. The net potential for leads I and aVF is plotted on the axes of the respective leads, with the base of the potential at the point of intersection of the axes. If the net potential of the lead is positive, it is plotted in the positive direction. Conversely, if this potential is negative, it is plotted in a negative direction.
4. Draw perpendicular lines from the apices of leads I and aVF potentials. The point of intersection of these two perpendicular lines represents the apex of the mean QRS vector in the ventricles, and the point of intersection of the lead I and lead aVF axes represents the negative end of the mean vector. Therefore, the mean QRS vector is drawn between these two points.
5. To determine the axis ,measure the angle created by the vector using a **protractor** or use the tangent rule

The tangent of the angle = $\frac{\text{the length of the opposite side}}{\text{the length of the adjacent side}}$

Example on the mathematical method :



Lead 1 =-6 mm
Lead avF =5 mm



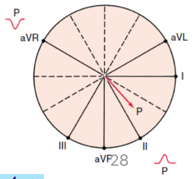
Tan ^-1= 6/5 = 50 degrees
But the angle of the vector should be taken from the zero reference point clockwise , so the angle of the vector =90+50=140 degrees Right axis deviation

Ventricular conditions that cause axis deviation :

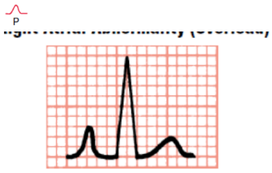
Left axis deviation : -deep expiration
- lying down
- obesity
- hypertrophy of the left ventricle
- left bundle branch block (also leads to widening of the QRS complex)

Right axis deviation : - deep inspiration
- standing up
- hypertrophy of the right ventricle
- right bundle branch block (also leads to widening of the QRS complex)

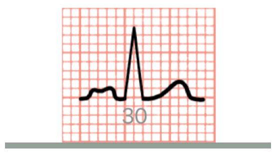
P wave : - atrial depolarization
- the axis of the atrial depolarization =70 degrees
- in the normal sinus rhythm, the p wave should be negative in lead avR and positive in lead 2
- maximum height of p wave is 2.5 mm (should not exceed 3 small squares)
- the duration of the p wave is shorter than 0.12 seconds (shorter than 3 small squares)



P wave abnormalities: 1- p pulmonale : right atrial enlargement results in a p wave that is higher and narrower than usual . 2- p mitrale : left atrial enlargement results in a notched p wave with a prolonged duration

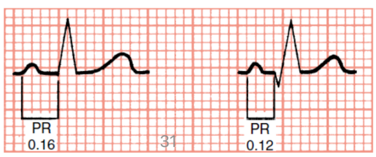


P pulmonale



P mitrale

PR interval : - from the beginning of the p wave to the beginning of the QRS complex
- normal PR interval : 0.12 -0.2 seconds (not longer than 5 small squares)
- short PR interval : abnormally fast conduction from the atria to the ventricles)
- long PR interval : first degree heart block



QRS Complex : - Q wave is the first negative deflection
- R wave is the first positive deflection
- S wave is any negative deflection following the R wave
- normal duration of the QRS complex : 0.06 -0.1 seconds
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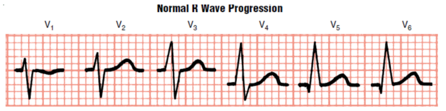
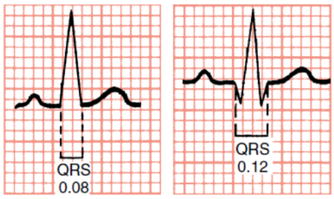
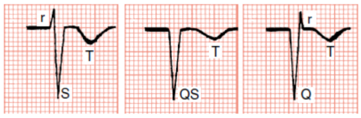




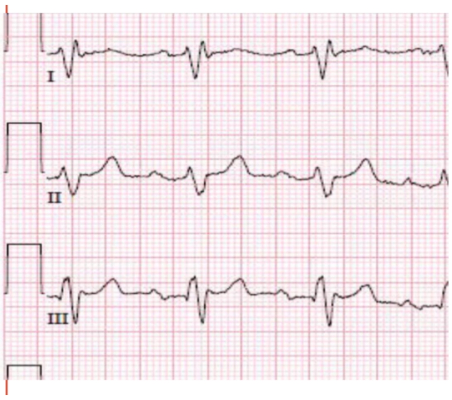
- Normally, the voltages in the three standard bipolar limb leads vary between 0.5 and 2.0 millivolts,
- When the sum of the voltages of all the QRS complexes of the three standard leads is greater than 4 millivolts, the patient is considered to have a high-voltage electrocardiogram.



Limb leads in normal ECGs can show a variable QRS pattern.

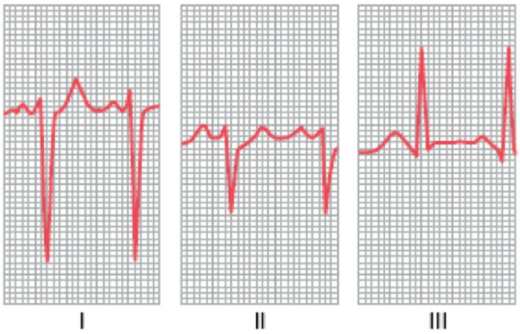
Lead aVR normally always records a predominantly negative QRS complex.

The QRS patterns in the other limb leads vary depending on the electrical position (QRS axis) of the heart.



QRS abnormalities: -increased QRS width : 1-cardiac hypertrophy or dilatation
2- bundle branch block (QRS duration >0.0.12 seconds (longer than 3 small squares))

- low voltage : old myocardial infarction , pericardial or pleural effusion
- high voltage : cardiac hypertrophy



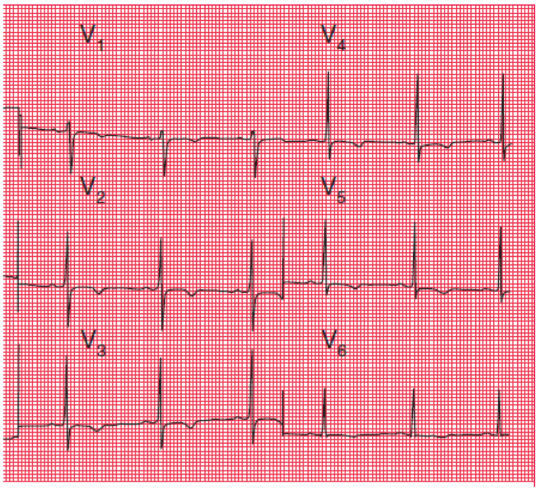
High voltage

Low voltage

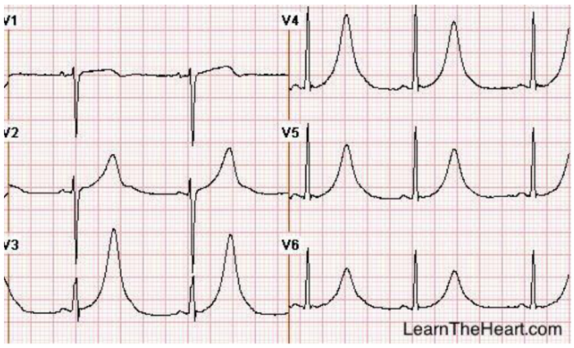
T Wave : - repolarization of the ventricles
- the apex of the heart of the first to repolarize while the endocardialmareas are the last to repolarize
- the overall vector during repolarization is towards the apex of the heart
- T wave deflection should be the same as the QRS deflection
- normally , the T wave is positively deflected in all leads except lead 1 and lead aVR
- when compared to the QRS compels it has a longer duration (because repolarization occurs slower than the depolarization) but a lower voltage .
- the height of the T wave should not exceed 10 mm (10 small squares) in the chest leads , and 5 mm (5 small squares) I'm the limb leads .

T Wave abnormalities:

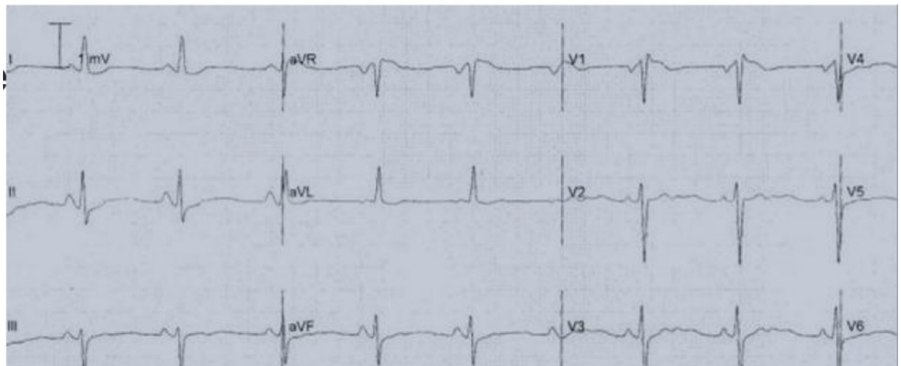
1 -T wave inversion : mild ischemia , ventricular hypertrophy, bundle branch block , digoxin toxicity



2- peaked and tall T waves : early stages of MI , Hyperkalemia



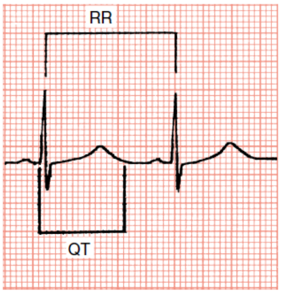
3- flat T Wave : hypokalemia , ischemia



QT interval

- the time From the beginning of the QRS complex to the end of the T wave
- QT corrected = QT observed / square root of the R-R interval
- prolonged Qt interval : hypokalemia , hypercalcemia , hypothyroidism, long QT syndrome
- the QT corrected should be less than 0.44 seconds

Example on the Qt corrected



QT= 0.6 sec
RR = 0.92
QTc = 0.63

ST Segment :

- Extends from the end of the QRS complex to the beginning of the T wave
- Should be isolectric
- Compare it to the T-P segment
- **Should be checked in all leads**
- Depressed or raised in ischemia or myocardial infarction
- To be considered significant , <u>more than 1 mm of ST</u> segment elevation/depression in <u>at least two contiguous limb</u> leads (e.g. I and VL; III and VF), <u>or more than 2 mm</u> of ST segment elevation/depression <u>in at least two contiguous chest leads</u>

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Contiguous leads : the leads that view the heart from the same anatomical perspective.
Examples : lead 2 , lead 3 and lead avF : observe the heart from the inferior view
lead avL , lead 1 , lead V5 and lead V6 : observe the heart from the lateral view