Electrocardiogram ECG

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Tuesday  29 October 2013   ECG introduction

Wednesday  30 October 2013   Abnormal ECG (ischemia, chamber hypertrophy, heart block)

Thursday   31 October 2013   dysrrhythmia I

Tuesday   5 November 2013   dysrrhythmia II

Wednesday  6 November 2013   Heart failure I

Thursday  7 November 2013   Heart failure II
Objectives

1. Describe the principles of cardiac anatomy and physiology in relation to ECG.

2. List the main 12 leads ECG electrodes and basic waves, intervals and complex.

3. Determine Heart rate, rhythm, axis from the ECG

4. Diagnose certain abnormalities, IHD, chamber enlargement, dysrhythmia
1903
Willem Einthoven
A Dutch doctor and physiologist. He invented the first practical electrocardiogram and received the Nobel Prize in Medicine in 1924 for it.

NOW
Modern ECG machine has evolved into compact electronic systems that often include computerized interpretation of the electrocardiogram.
ECG Machines!
Clinical utilities of the ECG

1. It is noninvasive inexpensive and highly versatile test

2. Useful in detecting
   a) Arrhythmias
   b) Conduction disturbances
   c) myocardial ischemia & infarction and
   d) metabolic disturbances such as Hyperkalemia and Hypokalemia
What is ECG?

Electrocardiography-is transthoracic interpretation of the electrical activity of the heart over time captured and externally recorded by skin electrodes for diagnostic or research purposes on human hearts.
Definitions

• Automaticity: ability of self stimulation.

• Rhythmicity: forming impulses at regular intervals.

• Refractory period: time during which the cardiac tissue is refractory to be stimulated

• Conductivity

• All or none response.

• Contractility
Conductive Tissue of the Heart

- Sino atrial node SA node
- Intra atrial tracts
- Atrio-ventricular node AV node
- Atrio-ventricular junction
- Bundle of Hiss: Left Bundle branch LBB
  - Anterior fascicle
  - posterior fascicle
  - Right Bundle Branch
- Purkinje fibers
Spontaneously firing cells are located:
1. Sino-atrial node (right atrial wall near opening of superior vena cava)
2. Atrio-ventricular node (base of right atrium near septum, just above A-V junction)
3. Bundle of His, bundle branches, Purkinje fibres
Pace Maker

- The tissue with higher rate of discharging impulses, usually the SA node (60-100/min)
- Other pacemakers:
  - Atrial tissue 60-80/min.
  - A-V junction 40-60/min.
  - Purkinje system 20-40/min.
IMPORTANT RULES FOR INTERPRETATION

Depolarisation moving away from a positive electrode gives a downward deflection.
Depolarization moving towards a positive electrode gives an upward deflection.

Amplitude is maximal when the positive electrode is on the vector and minimal/biphasic when perpendicular.
The ECG paper

• Thermal sensitive paper
• Measured tow elements: Time & Voltage

Horizontal plane measure the time

Vertical plane measure the voltage

Basic element of the ECG paper is a small square

1 mm = 0.04 sec. in the horizontal plane

& 1 mm = 0.1 mvolt. In the vertical plane
The graph paper recording produced by the machine is termed an electrocardiogram, It is usually called ECG or EKG.

**STANDARD CALLIBRATION**

- **Speed** = 25mm/s
- **Amplitude** = 0.1mV/mm

1mV \(\rightarrow\) 10mm high
1 large square \(\rightarrow\) 0.2s (200ms)
1 small square \(\rightarrow\) 0.04s (40ms)
or 1 mV amplitude
These are all electrodes

Place all the electrodes correctly
LEADS I, II, III

They are formed by voltage tracings between the limb electrodes (RA, LA, RL and LL). These are the only bipolar leads. All together they are called the **limb leads** or **Einthoven's triangle**.
Limb Leads and Their Axes

An ECG lead provides a graphic illustration of the electrical potential difference between two points on the skin surface. The leads shown below are the bipolar limb leads, which use two electrodes (a positive + and a negative -) to record the electrical potential difference in the frontal plane.

Click red asterisk for more information
LEADS aVR, aVL, aVF

They are also derived from the limb electrodes, they measure the electric potential at one point with respect to a null point. They are the augmented limb leads.
Augmented Limb Leads and Their Axes

The leads shown below are called the augmented limb leads, which also record the electrical potential in the frontal plane. They are called unipolar leads, however, because the center of the heart is used as a reference point and the electrode (positive +) is placed on the limbs and used as the other point.

In the augmented limb leads, one limb electrode is used for the positive electrode and the other two are joined to form a ground reference.
Unipolar Chest Leads

- V1: 4th Rt intercostal space
- V2: 4th Lt intercostal space
- V3: between V2 & V4
- V4: 5th intercostal space mid clavicular line.
- V5: 5th intercostal space anterior axillary line.
- V6: 5th intercostal space mid axillary line
LEADS
V1, V2, V3, V4, V5, V6

They are placed directly on the chest. Because of their close proximity of the heart, they do not require augmentation. They are called the PRECORDIAL LEADS.
Horizontal plane - the six chest leads
ECG Interpretation

The More You See, The More You Know
Important points in the ECG

- Correct labeling of the ECG: name, age & exact timing.
- Correct connection.
- Correct Calibration: 10 mm = 1 m volt.
- Correct speed (25 mm/sec.)
STANDARDISATION
ECG amplitude scale

Normal amplitude
10 mm/mV

Half amplitude
5 mm/mV

Double amplitude
20 mm/mV
Components of ECG

- Base line or isoelectrical line.
- Wave: positive (upward), negative (downward).
- Segment: length between 2 waves, named by the wave before and after.
- Interval: length of wave or segment.
- Complex: group of waves in sequence, QRS complex.
OBTAIN A N ECG, ACT CONFIDENT, READ THE PT DETAILS

Example of a complete 12-lead EKG (ECG)
The best way to interpret an ECG is to do it step-by-step

- Rate
- Rhythm
- Cardiac Axis
- P – wave
- PR - interval
- QRS Complex
- ST Segment
- QT interval (Include T and U wave)
- Other ECG signs
TERMINOLOGY – labelling the waves

• The rules:-
  
i) the first wave, irrespective of its polarity,

ii) is always called a P wave

iii) the final wave is called a T wave

iv) (unless U waves (rare) are present

v) the first positive wave after a P wave is

vi) called an R wave
i) any negative wave after a P wave but before an R wave is called a Q wave

ii) any negative wave after an R wave is called an S wave
A NORMAL ECG WAVE

REMEMBER
Definitions

• P wave = Atrial depolarization.
• PR interval = Time for the impulse to travel from SA node to Myocardium.
• QRS = ventricular depolarization
• ST segment = Isoelectrical period before repolarization
• T wave = ventricular repolarization
Understanding ECG Waveform

If a wavefront of depolarization travels towards the positive electrode, a positive-going deflection will result. If the waveform travels away from the positive electrode, a negative going deflection will be seen.
THE NORMAL SIZE

<3 small square

QRS Complex

< 2 small square

3-5 small square

P Segment

< 2 large square

PR Interval

ST Segment

QT Interval

T
Connection

Misplacement of placement results in abnormal ECG and misdiagnosis
P- WAVE
Normal P-wave
3 small square wide, and 2.5 small square high.
Always positive in lead I and II in NSR
Always negative in lead aVR in NSR
Commonly biphasic in lead V1
The ECG components

P wave - represent atrial contraction or depolarization
Duration = 3mm (3 small sq.) Height = 2.5 mm
Usually the 1st +ve deflection except in lead aVR
Usually rounded
Notched P wave - LT atrial enlargement (lead II) Biphasic usually in lead V1, pecked P wave RT atrial enlargement (lead III)
Fig. 3.2 Diagrams illustrating the normal P wave, the P wave of right atrial enlargement, and the P wave of left atrial enlargement.
<table>
<thead>
<tr>
<th><strong>P-Pulse</strong></th>
<th><strong>P pulmonale</strong></th>
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<tbody>
<tr>
<td>Tall peaked P wave. Generally due to enlarged right atrium - commonly associated with congenital heart disease, tricuspid valve disease, pulmonary hypertension and diffuse lung disease.</td>
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<tr>
<th><strong>Biphasic P wave</strong></th>
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<td>Its terminal negative deflection more than 40 ms wide and more than 1 mm deep is an ECG sign of left atrial enlargement.</td>
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<tr>
<th><strong>P mitrale</strong></th>
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<td>Wide P wave, often bifid, may be due to mitral stenosis or left atrial enlargement.</td>
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PR- INTERVAL
PR INTERVAL

NORMAL PR INTERVAL

PR-Interval 3-5 small square (120-200ms)

Long PR interval may indicate heart block

Short PR interval may disease like Wolf-Parkinson-White
QRS-COMPLEX
QRS COMPLEX

NORMAL QRS COMPLEX

- Q wave amplitude less than 1/3 QRS amplitude (R+S) or < 1 small square
- QRS complex < 3 small square (0.06 - 0.10 sec)

Increased amplitude indicated **cardiac hypertrophy**

S amplitude in V1 + R amplitude in V5 < 3.5

Prolonged indicates **hyperkalemia** or **bundle branch block**
Normal Q wave

Differential Diagnosis of Q Waves

Nonsignificant Q wave
Q wave in MI

Differential Diagnosis of Q Waves

Presence of significant Q wave
The R wave in the precordial leads must grow from V1 to at least V4
ST- SEGMENT
ST SEGMENT

NORMAL ST SEGMENT

ST segment < 2-3 small square (80 to 120 ms)

ST segment is isoelectric and at the same level as subsequent PR-interval
ST Segment Elevation

↑ 1 mm above baseline (limb)
↑ 2 mm above baseline (chest)
.08 sec to right of J point
Look for in two or more leads facing same area
QT- INTERVAL
As a general guide the QT interval should be 0.35-0.45 s, (<2 large square) and should not be more than half of the interval between adjacent R waves (R-R interval).
If abnormally prolonged or shortened, there is a risk of developing ventricular arrhythmias.

The QT interval is prolonged in congenital long QT syndrome, but QT prolongation can also occur as a consequence of:
- Medication (anti-arrhythmics, tricyclic antidepressants, phenothiazides)
- Electrolyte imbalances
- Ischemia.

QT prolongation is often treated with beta blockers.
The T wave: ventricular repolarization

Usually Up in lead I, II, V3-V6
Usually down in aVR
Usually variable in lead III, aVF, aVL, V1, V2
Shape: usually rounded, pecked seen in MI
Height 5 mm in limb leads, 10 mm in chest leads
Tall T wave in MI, CVA, Hyperkalemia
T WAVE
T wave
U Wave

* May be seen in normal ECG usually after the T wave especially in lead V3.
* Same direction of T wave.
* Become prominent in hypokalemia
* Becomes opposite to T wave direction in Myocardial ischemia
U Wave