ECG, Holter ECG and Echocardiography

Division of Cardiology
Taha Othmane
Heart Beat Anatomy

Sinus Node (SA Node)

SINUS NODE

- The Heart’s ‘Natural Pacemaker’
- 60-100 BPM at rest
Heart Beat Anatomy

**AV NODE**

- Receives impulse from SA Node
- Delivers impulse to the His-Purkinje System
- 40-60 BPM if SA Node fails to deliver an impulse
Heart Beat Anatomy

Sinus Node (SA Node)

Atrioventricular Node (AV Node)

Bundle of His

BUNDLE OF HIS

- Begins conduction to the Ventricles
- AV Junctional Tissue: 40-60 BPM
Heart Beat Anatomy

THE PURKINJE NETWORK

- Bundle Branches
- Purkinje Fibers
- Moves the impulse through the ventricles for contraction
- Provides ‘Escape Rhythm’: 20-40 BPM
Impulse Formation In SA Node
Atrial Depolarization
Delay At AV Node
Conduction Through Bundle Branches
Conduction Through Purkinje Fibers
Ventricular Depolarization

Action potential
Inflow of sodium
Plateau Phase (phase 2) of Repolarization

Action potential
Outflow of calcium and potassium
Final Rapid (Phase 3) Repolarization

Action potential
Outflow of potassium
Making ECG (Standard conditions)

- Positioning electrodes
- Reference pulse
- Speed of ECG-paper
Standard conditions

Positioning electrodes

- R (Right)
- L (Left)
- N (Neck)
- F (Foot)

- V1, V2, V3, V4, V5, V6
- Mid-clavicular line
- Anterior axillary line
Standard conditions

Reference pulse
Standard conditions

Speed of ECG-paper

<table>
<thead>
<tr>
<th>Name:</th>
<th>12-Lead 2</th>
<th>HR 62 bpm</th>
<th>Normal ECG<strong>Unconfirmed</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>ID:</td>
<td></td>
<td>14:37:10</td>
<td>Normal sinus rhythm</td>
</tr>
<tr>
<td>Patient ID:</td>
<td></td>
<td>0.39s/0.395s</td>
<td></td>
</tr>
<tr>
<td>Incident:</td>
<td></td>
<td>0.112s</td>
<td></td>
</tr>
<tr>
<td>Age: 26</td>
<td></td>
<td>27° 88° 45°</td>
<td></td>
</tr>
</tbody>
</table>

**25mm/sec**
Evaluating ECG

- Rhythm
- Frequency
- Heart axis
- Transit times
- Transition zone
- Repolarization
Heart rate

300 Rule

\[ 300/4 = 75/\text{min} \]
Heart axis

I-avF Rule

EHO Taha 2013
# Heart Axis

## I-avF Rule

<table>
<thead>
<tr>
<th>Lead I</th>
<th>Lead avF</th>
<th>Heart axis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>Positive</td>
<td>Normal axis</td>
</tr>
<tr>
<td>Positive</td>
<td>Negative</td>
<td>Left axis</td>
</tr>
<tr>
<td>Negative</td>
<td>Positive</td>
<td>Right axis</td>
</tr>
<tr>
<td>Negative</td>
<td>Negative</td>
<td>Indeterminate</td>
</tr>
</tbody>
</table>
Intervals and timing

Normal Ranges in Milliseconds:

- PR Interval 120 - 200 ms
- QRS Complex 60 - 100 ms
- QT Interval 360 - 440 ms
Pathological changes

- P wave
- PR interval
- QRS complex
- ST segment
- T wave
- QT interval
P-wave

Increased P-wave amplitude (> 2.5 mm)

- Stenosis of pulmonal, tricuspidal valve
- Pulmonary Hypertension
P-wave

Widened P-wave (> 80 ms)

- Lift atrial enlargement (mitral stenosis or regurgitation)
P-wave

Biphasic P-wave

- Mitral stenosis or regurgitation
- Aortic stenosis or regurgitation
- Hypertension
Absence of P-wave

- Sino-atrial block
- AV nodal rhythm
PR interval

**Prolonged PR-interval (>220 ms)**

- AV block
- Drugs (digoxin, beta blockers)
- Ischemia
PR interval

Shortened PR interval (<120 ms)

- WPW, LGL
- Ectopic atrial rhythm
QRS

Narrow QRS complex

- Sinus rhythm
- Supraventricular extranodal tachyarrhythmia (flutter, fibrillation, SVES)
Increased QRS amplitude

- Ventricular hypertrophy
- Fever, anemia
QRS

Decreased QRS amplitude

- Pericardial fluid
- Extensive myocardial infarction
- Myocarditis, myocardial fibrosis
Prolonged QT-interval \((\text{QTc}>440 \text{ ms})\)

- Hypokalemia, hypocalcemia
- Alkalosis
- Cardiomyopathies
- Mitral valve prolapse
- Drug effects
Shortened QT-interval (QTc<300 ms)

- Hyperkalemia
- Hypercalcemia
- Hypermagnesemia
- Acidosis
- Digoxin effect
ST segment

ST depression

- Ischemia, infarction
- Ventricular hypertrophy
- Mitral prolapse
- Myocarditis
- bundle branch block
- Digoxin effect
- Hypokalemia
ST segment

ST elevation

- Ischemia, infarction
- Ventricular aneurysm
- Prinzmetal angina
- Acute pericarditis
- LBBB

atypical

typical
T wave

Negative T wave

- Ischemia, infarction
- Pericarditis, myocarditis
- Ventricular hypertrophy
- DCM
- Digoxin effect
High T wave: (>5 mm)

- Ischemia, hyperacute myocardial infarction
- Hyperkalemia
- Ventricular hypertrophy
Flat or low T wave

- Hypokalemia
- Pericardial fluid, myocarditis
- Ischemia, anterior acute myocardial infarction
ECG

Indication

• Organic and unavoidable complement of physical examination,
• Palpitations,
• Suspicion of myocardial ischemia,
• Suspicion of rhythm disorder (tachy-, bradycardia),
• Efficacy of applied therapy
Holter ECG

Recording the heart's electrical activity for 24 to 48 hours
Holter ECG

Beside everyday normal activities
Holter ECG

Event-registration

palpitation

Presyncopal symptoms

chest discomfort
Holter ECG

ECG Analysis

– Automatic
– Manual
Holter ECG

The **temporal comparison** of ECG abnormalities and symptoms.

- Temporal association between symptoms and observed ECG abnormalities?
- ECG abnormalities explain the symptoms?
Holter ECG

Indication

- Palpitations,
- Syncope, presyncope, dizziness,
- Efficacy of applied therapy,
- Myocardial ischemia
- Heart rate variability
- Pacemaker function
Echocardiography

- Using the conventional ultrasound techniques to form two-dimensional slices of the heart.

- Routinely used in the diagnosis, management, and follow-up of patients with any suspected or known heart diseases.
Echocardiography

- **Ultrasound**: sound frequency is higher than 20000 Hz,
- **Hatching ultrasound**: piezoelectricity,
- **Ultrasound propagation**: the frequency is constant, the wavelength decreases,
- **Ultrasound reflection**: some of reflect from the borderline of mediums with different impedance
Echocardiography

- Suitable system can reconstruct the image using the reflected acoustic energy
Echocardiography

**TTE (transthoracal):**

- standard test
- transducer (or probe) is placed on the chest wall of the subject, and images are taken through the chest wall
Echocardiography

**TEE (tranceosophageal):**

- If the standard test can’t provide information or if more information is needed.
- An ultrasound transducer at its tip is passed into the patient's esophagus
Echocardiography (views)
Echocardiography (Techniques)

- Two dimensional (2D)
- M mode
- Color doppler
Echocardiography (2D)

Two-dimensional representation of the structures
Echocardiography (2D)

Morphological description and comparison of the structural elements
Echocardiography (2D)

Detection of pathological processes (eg pericardial fluid)
Echocardiography (M mode)

Demonstrating the movement of different boundary of heart in the function of time
Echocardiography (M mode)

To measure the wall-thickness and dimensions of cavities
Echocardiography (M mode)

To determine parameters (EF and FS)
**Continuous Wave:**

- continuously emitted and detected sound waves
- detect the high-speed (aortic outflow velocity)
Pulsed Wave:

- Sequentially emitted and detected sound waves
- Detect the low-speed (mitral inflow velocity)
Echocardiography (doppler)

The representation and measurement of hemodynamic conditions:

- **Flow-velocity** (aortic outflow, mitral inflow)

- **Transvalvular pressure gradient**
Indications of Echocardiography

Valvular heart disease
(suspected or known)

• heart murmur
• Valve stenosis, insufficiency
Indications of Echocardiography

Heart tumors, suspected thrombus

- Atrial myxoma
- Intracardiac thrombus
  (peripheral embolic complications)
Indications of Echocardiography

Acute coronary syndrome (ACS)

- Wall motion disorder
- Complications (wall rupture, aneurysm)
Indications of Echocardiography

Suspicion of
Heart failure or cardiomyopathy
Indications of Echocardiography

Pericardial disease

- Pericardial effusion
- Constrictive pericardial disease
Three dimensional ECHO
Contraindications!

No contraindications in accomplishing new or control ECG, Holter-ECG and echocardiography
THANK YOU