ECG Pattern Recognition

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Recommended ECG Book

+ECGpedia
ECG Interpretation: Steps

• Identify common ECG pattern
• Underlying electrophysiologic disturbance

• Pathophysiology
• Differential diagnosis
- Step 1: Rhythm
- Step 2: Rate
- Step 3: Conduction (PQ, QRS, QT)
- Step 4: Heart axis
- Step 5: P wave morphology
- Step 6: QRS morphology
- Step 7: ST morphology
Group 1
Group 1
Group 1

17-OCT-1970 (23 yr)
Female Caucasian

17-DEC-1994 21:37
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ECG Interpretation: Steps

- Identify common ECG pattern
- Underlying electrophysiologic disturbance
- Pathophysiology
- Differential diagnosis
Group 1: STEMIs

- ST segment morphology

ST ELEVATION:

Concave Upward  Convex Upward

Q wave duration = 1 small box = 0.04 seconds

EVOLUTION OF STEMI

1. Before infarction
   - P, Q, S, T
2. Hyperacute T
   - ST elevation
3. T inversion
   - Q wave
4. Coronary T
   - Q wave
5. Months

Minutes → Hours
Hours → 1 day
1 week
Months
Early Repolarization: Normal Variant
Group 2
Group 2
Group 2
Group 2
Group 2: Ischemic ST changes
Group 3
Group 3
Group 3
Group 3
Group 3: AV Blocks

30. AV block, 2° - Mobitz Type I (Wenckebach)
   - Progressive prolongation of the PR interval and progressive shortening of the RR interval until a P wave is blocked
   - Note: The progressive shortening of the RR interval is due to a decrease in the beat-to-beat increment of PR prolongation.
   - RR interval containing the nonconducted P wave is less than two PP intervals

31. AV block, 2° - Mobitz Type II
   - Regular sinus or atrial rhythm with intermittent nonconducted P waves and no evidence for atrial prematurity
   - PR interval in the conducted beats is constant
   - RR interval containing the nonconducted P wave is equal to two PP intervals
   - Note: Type II second-degree AV block usually occurs within or below the bundle of His; the QRS is wide in 80% of cases.
Rhythm Strip:?
Rhythm Strip: 2\textsuperscript{nd} degree Type 1 AV Block
Rhythm Strip: ?
Rhythm Strip: 2\textsuperscript{nd} degree AV block, type 1 or 2
Rhythm Strip: ?
Rhythm Strip: 2\textsuperscript{nd} degree AV block, type 2
Group 4
Group 4
Group 4
Group 4
### Group 4: Ventricular hypertrophy

**QRS criteria for RVH:**
- Right axis deviation (>90 degrees)
- An R/S ratio > 1 in lead V1
- An R wave > 7 mm tall in Vl, (not the R' of RBBB)
- An rsR' complex in V 1 (R' > 10 mm)
- An S wave > 7 mm deep in leads V5 or V6

<table>
<thead>
<tr>
<th>Criteria in Males</th>
<th>Sens</th>
<th>Spec</th>
<th>LR+</th>
<th>LR-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cornell voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RaVL +SV3 &gt;25 mm)</td>
<td>19.1</td>
<td>95.0</td>
<td>3.8</td>
<td>0.9</td>
</tr>
<tr>
<td>Max [SV1, SV2, RV5, or RV6] ≥ 30 mm</td>
<td>17.8</td>
<td>95.1</td>
<td>3.6</td>
<td>0.9</td>
</tr>
<tr>
<td>RaVL &gt;11 mm</td>
<td>16.4</td>
<td>95.1</td>
<td>3.3</td>
<td>0.9</td>
</tr>
</tbody>
</table>

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<tr>
<th>Criteria in Females</th>
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<tr>
<td>Cornell voltage</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(RaVL +SV3 &gt;20 mm)</td>
<td>18.6</td>
<td>95.0</td>
<td>3.7</td>
<td>0.9</td>
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<tr>
<td>RaVL &gt;11 mm</td>
<td>10.1</td>
<td>98.2</td>
<td>5.6</td>
<td>0.9</td>
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<tr>
<td>RV5 or RV6 &gt;25 mm</td>
<td>8.0</td>
<td>97.8</td>
<td>3.6</td>
<td>0.9</td>
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</tbody>
</table>

**Classical LVH:**
- LVH voltage with typical repolarization abnormalities and QRS widening

**Incomplete LBBB:**
- Absent septal Q in leads I and V6

**Complete LBBB:**
- Absent septal Q in leads I and V6
Group 5
Group 5
Group 5
Group 5
Group 5
Group 5: Bundle Branch Blocks

5. QRS Duration

What it Represents
Duration of ventricular activation

How to Measure
In seconds, from the beginning to the end of the QRS (or QS) complex

QRS duration = 1.5 small boxes = 0.06 sec.

Definitions
- Normal QRS duration: < 0.10 seconds
- Increased QRS duration: ≥ 0.10 seconds

Note: For the purposes of establishing a differential diagnosis, it is often useful to distinguish moderate prolongation of the QRS (0.10 to ≤ 0.12 seconds) from marked prolongation of the QRS (> 0.12 seconds)
Rhythm Strip:?
Rhythm Strip: Premature Atrial Contractions
Rhythm Strip:?
Rhythm Strip: Premature Atrial Contractions with Aberrant Conduction
Effect of Blocks on Axis

RBBB:  
Axis unaffected (determined by LBB)

LPFB:  
Initial depolarization lateral  
QRS axis down and to the right  
Negative in lateral leads

LAFB:  
Initial depolarization inferior  
QRS axis up and to the left  
Negative in inferior leads
Group 6
Calculating Heart Rate

Heart Rate = 300 \div \text{no. large boxes between “R” Waves} = 300 \div 3 = 100 \text{ bpm}
Group 6
Group 6
Group 6
Group 6
Group 6
Narrow QRS tachycardia (QRS duration less than 120 ms)

Regular tachycardia?

Yes

No

Visible P waves?

Yes

Atrial fibrillation
Atrial tachycardia/flutter with variable AV conduction
MAT

No

Atrial rate greater than ventricular rate?

Yes

Atrial flutter or Atrial tachycardia

No

Analyze RP interval

Short (RP shorter than PR)

RP shorter than 70 ms

AVNRT

AVRT AVNRT Atrial tachycardia

RP longer than 70 ms

Long (RP longer than PR)

Atrial tachycardia Atypical AVNRT
Group 6: Tachycardias

Heart Rate > 100 BPM

Narrow QRS (< 0.12 sec) - Regular R-R
- Sinus P: Sinus tachycardia
- Flutter waves: Atrial flutter
- No P: AV nodal reentrant tachycardia (AVNRT), junctional tachycardia
- Short R-P (R-P < 50% of R-R interval): AVNRT, orthodromic SVT (AVRT), atrial tachycardia with 1° AV block, junctional tachycardia with 1:1 retrograde atrial activation
- Long R-P (R-P > 50% of R-R interval): Atrial tachycardia, sinus node reentrant tachycardia, atypical AVNRT, orthodromic SVT with prolonged V-A conduction

Narrow QRS - Irregular R-R
- Nonsinus P; > 3 morphologies: Multifocal atrial tachycardia
- Fine or coarse baseline oscillations: Atrial fibrillation
- Flutter waves: Atrial flutter
- Any regular rhythm with 2°/3° AV block or premature beats

Wide QRS (≥ 0.12 seconds)
- Sinus or nonsinus P: Any regular or irregular supraventricular rhythm with a preexisting IVCD or aberrancy
- No P; rate 100-110: Accelerated idioventricular rhythm
- No P, rate 110-250: VT, SVT with aberrancy
- Irregular, polymorphic, alternating polarity: Torsade de Pointes
- Chaotic irregular oscillations; no discrete QRS: Ventricular fibrillation
Rhythm Strip:?
Rhythm Strip: Ventricular fibrillation
Rhythm Strip:?
Rhythm Strip: Torsade de Pointes
Long QT
Delta Wave
Group 7
Group 7
Group 7

Short QT

Osborn or J wave
Group 7
Group 7: Electrolyte Abnormalities

ECG changes depend on serum K⁺ level and rapidity of rise:
- \( K^+ = 5.5 - 6.5 \text{ mEq/L} \)
  - Tall, peaked, narrow based T waves
    - **Note:** Generally defined as > 10 mm in precordial leads and > 6 mm in limb leads. May also be seen as normal variant or in acute MI, LVH, or LBBB
  - QT interval shortening
  - Reversible left anterior fascicular block (item 45) or left posterior fascicular block (item 46)
- \( K^+ = 6.5 - 7.5 \text{ mEq/L} \)
  - First-degree AV block (item 29)
  - Flattening and widening of the P wave
  - QRS widening
- \( K^+ > 7.5 \text{ mEq/L} \)
  - Disappearance of P waves, which may be caused by:
    - Sinus arrest (item 11), or
    - “Sinoventricular conduction” (sinus impulses conducted to the ventricles via specialized atrial fibers without atrial depolarization)
  - LBBB (items 47, 48), RBBB (items 43, 44), or markedly widened and diffuse intraventricular conduction disturbance (item 49) resembling a sine-wave pattern

75. Hypokalemia

Suggested by the following:
- Prominent U waves (item 69)
- ST segment depression and flattened T waves
  - **Note:** The ST-T and U wave changes of hypokalemia are seen in approximately 80% of patients with potassium levels < 2.7 mEq/L, compared to 35% of patients with levels of 2.7-3.0 mEq/L, and 10% of patients with levels >3.0 mEq/L.
- Increased amplitude and duration of the P wave
- Prolonged QT sometimes seen
  - **Note:** If potassium replacement does not normalize the QT interval, suspect hypomagnesemia.
- Arrhythmias and conduction disturbances, including paroxysmal atrial tachycardia with block, first-degree AV block (item 29), Type I second-degree AV block (item 30), AV dissociation (item 35), VPCs (item 23), ventricular tachycardia (item 25), and ventricular fibrillation (item 28).
76. Hypercalcemia

- QTc shortening (usually due to shortening of the ST segment)
- May see PR prolongation

**Note:** Little if any effect on P, QRS, or T wave.