Tackling the Intimidation of the 12 Lead EKG

If 12 Lead EKGs are not large enough to see, zoom pdf to larger %
Or on www.cherylherrmann.com under Critical Diagnosis, look at the Correlate the Coronary Arteries. That lecture is very similar and saved as one slide per page.
Happy Education!

Cardiac Anatomy Review

12 Lead EKG 101
Learn the Normal so you can detect the abnormal

To Learn 12 Lead EKG
You MUST pick them up and LOOK at them!

Leads Are Like Pictures
Camera is on the positive lead

To Learn 12 Lead EKG
You MUST pick them up and LOOK at them!
The 12 Leads

Bipolar Leads
Each lead has two poles:
One positive & one negative
I, II, III

Unipolar Leads
Only one lead is physically positive.
Negative lead is not a specific site on the body
AVR, AVL, AVF, V1-V6

Cube Concept of Left Ventricle

Each face of the cube represents a different part of the left ventricle

LIMB LEADS
I, II, III

- Also referred to as extremity leads due to placement on the body
- Record electrical forces two points equidistant from the heart.
- Each lead has two poles: one positive & one negative
- Two leads to give the picture
- Current travels Negative to Positive to create the electrical complex
- 12 Lead EKG Reads or takes the picture from the positive electrode to the heart

Lead I
Views the heart from left arm to right arm
Area: Lateral
Artery: Circumflex

Lead II
Views the heart from left leg to right arm
Area: Inferior
Artery: RCA

Lead III
Views the heart from left leg to left arm
Area: Inferior
Artery: RCA
Einthoven’s Triangle

Augmented Limb Leads
AVR, AVL, AVF
- Records electrical activity between the center of the heart and an extremity
- Since these leads are low voltage they are artificially augmented
- Unipolar leads: Negative pole is the heart

AVR
Augmented Voltage Right
- Views electrical activity directed rightward.
- Very minimal rightward electrical activity occurs.
- Looks at great vessels no myocardium
- Configuration should be negative

AVL
Augmented Voltage Left
- Views the heart from the left arm to the mid-point between right arm & right leg
- Area: Lateral
- Artery: Circumflex

AVF
Augmented Voltage Foot
- Views the heart from the feet to the chin
- Area: Inferior
- Artery: RCA

Correlation of the leads to the areas of left ventricle by superimposing Einthoven’s Triangle over the cube.
The Precordial System
Chest Leads V1 – V6

- Records electrical activity of the heart by placing electrodes on the anterior chest wall
- Heart is the negative pole
- Positive pole is where the electrode is placed
- Unipolar leads

Precordial Leads Placement

- V1 4th intercostal space (ICS), right sternal border (septum)
- V2 4th ICS, left sternal border (septum)
- V3 Midway between V2 and V4 (anterior)
- V4 5th ICS, left midclavicular line (anterior)
- V5 5th ICS, left anterior axillary line (lateral)
- V6 5th ICS, left midaxillary line (lateral)

Precordial Leads

R Wave Transition
R: Rises above baseline

V1 & V2
Views the septum of the heart
Area: Septal
Artery: LAD

V3 & V4
Views the anterior area of the left ventricle
Area: Anterior
Artery: LAD
V5 & V6
Views the lateral area of the left ventricle
Area: Lateral
Artery: Circumflex

The 12 Lead EKG in Acute Coronary Syndrome
What is the camera looking for?

Cardiac Anatomy

Atherosclerosis

Cascade effects of atherosclerotic plaque rupture
- Platelet aggregation
- Fibrin accumulation
- Thrombus formation
- Bleeding into the plaque
- Vasospasm

Time Is Muscle
Muscle is Ejection Fraction
Ejection Fraction is Quality of Life

ARTERY OCCULUSION
Target

Door to Balloon < 90 minutes
(Class 1, Level A)
or
Door to Needle < 30 minutes
(Class 1, Level B)

ACC/AHA 2007 Focused Update Guidelines for Management of STEMI

CRUSADING towards a GOAL

Door to EKG
10 minutes or less
(Class 1, Level C)

EKG Changes with MI: Ischemia

Ischemia < 20 Minutes
Lack of oxygen to the myocardial muscle
● Peaked T Waves
● Inverted T Waves
● ST Segment Depression

Ischemia = screaming for oxygen

EKG Changes with MI: Injury

Injury 20 - 40 minutes
When the period of ischemia is prolong more than a few minutes, ischemic areas of the heart become damaged (injured)
● ST segment elevation

The ST Segment

● From the end of the QRS complex to the beginning of the T wave
● Should be at the baseline

Measurement of ST-Segment Deviation

STEMI: ≥1 mm ST-segment elevation in 2 leads.*
NSTEMI/UA: ≥0.5 mm ST-segment ischemic depression in 2 leads.*

*Anatomically (regionally) contiguous leads.
EKG Changes with MI Infarction

Infarction > 1 - 2 hours
- Abnormal Q waves
  - $1/3$ the height of R wave in that lead
  - or
  - $> 0.03$ ms wide

Abnormal (significant Q waves)

Normal Q wave
1st downward deflection of QRS

Normal QRS complex – The Q wave

- Q wave is the first negative deflection after the p wave
- Always first may or may not be there.
- There are normal and abnormal Q waves

Normal QRS complex – The R wave

- R wave is the first positive deflection after the p wave
- Always Rising above

Normal QRS complex – The S wave

- S wave is the second negative deflection after the R wave
- Slipping down
- Always after R wave like in the alphabet

EKG Changes with MI: Infarction

Infarction > 1 - 2 hours
- Abnormal Q waves
  - $1/3$ the height of R wave in that lead
  - or
  - $> 0.03$ ms wide

Abnormal (significant Q waves)

Normal Q wave
1st downward deflection of QRS

Evolving Inferior – Posterior AMI:
EM #1 December 13 at 1701
EM # 2 December 13 at 1823

EM #3 December 14 at 0630

EM # 4 December 15 0600

Hyperacute Phase of MI
- Occurs within minutes to first hour of chest pain
- Very tall ST segment
- Tall peaked symmetrical T waves

Acute Phase of MI
- Occurs in the first 24 hours
- ST segment elevation returns to baseline within 24 hours
- T wave inversion occurs in 24 - 48 hours and stays for two weeks
- Q wave develops after 48 hours
- R wave decreases

Evolving Phase of MI
- Occurs in the first week
- ST segment returns to normal
- T wave is deeper and inverted
- Q wave deepens
- R wave decreases more
Resolving Phase of MI
- Occurs in second week
- ST segment returns to normal
- T wave stops inverting and stays that way for 2 weeks and then resolves and will be low voltage
- Q wave stops deepening and stays due to dead tissue
- R wave stops decreasing and stays due to dead tissue

CC: Admission EKG 1445

CC: 3 hours later

CC: 28 hours later

Positive EKG
- ST elevation > 0.1 mV (1 mm) in at least 2 contiguous precordial leads or at least 2 adjacent limb leads (STEMI) (Class 1, Level A)
- Transient ST Elevation > 0.5 mm
- ST depression > 0.5 mm (NSTEMI)
- T wave inversion > 0.2 mV (2 mm)
- New LBBB (Class 1, Level A)

To learn you need to hear something
- 6 times
- 6 different ways

SIX

VI seis

Six
Correlate the Coronary Arteries

- Inferior – RCA – II, III, AVF
- Septal – LAD – V1, V2
- Anterior – LAD – V3, V4
- Lateral – Circumflex – I, AVL, V5, V6

Right Coronary Artery RCA Inferior Wall II, III, AVF

Occluded RCA RCA post stent

Inferior Injury

Old Inferior Infarction

Inferior AMI
- Involves right ventricle – may also get right ventricular infarct
- Need lots of fluids to increase preload since RV is involved
- Arrhythmias = Blocks
- RCA wraps around the back of the heart and changes to PDA. Typically have inferior – posterior AMI.
  - Inferior- Posterior AMI:
    - ST Elevation: II, III, AVF and
    - ST depression V1, V2, V3
Inferior AMI with complete heart block

Left Anterior Descending Artery LAD
Anterior Wall V3 & V4
Septal Wall V1 & V2

Anterior-septal Injury

Old Anterior Infarction

Precordial Leads

Occluded High LAD
LAD post stent
Anterior AMI
- Lose the most muscle mass
- Usually have the lowest EF
- Arrhythmias = VT or VF

Stress Test – Angio found 3 occlusions in the LAD

Circumflex Artery Cx
Lateral Wall
I, AVL V5 & V6

High Lateral Injury

Anterior Lateral Injury

Lateral Ischemia
**Posterior Descending Artery PDA**

**Posterior Wall**

**Reciprocal Changes**

- Usually see with Inferior AMI as RCA wraps around the back of the heart and changes to PDA
- Reciprocal Changes V1, V2, V3 (ST segment depression or Tall R Waves)
- 18 Lead EKG

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**Reciprocal Changes**

Reciprocal Leads that are opposite the damaged area will show opposite EKG Changes

- Mirror Image
- Two different electrodes viewing AMI from opposite angles

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**Inferior & Posterior Injury**

**Old Inferior-posterior Infarction**

Mirror Changes
**Differential Diagnosis**

- Peaked T waves
- T Wave inversion
- ST Depression
- ST Elevation
- Q waves
- Type of AMI
- Coronary Artery Involved

![ECG Tracings](image)
**Case Study: 42 year old male comes to ED (wife drives him)**

- Came to ED due to c/o substernal burning pain that radiates up chest to both arms.
- Becomes SOB with chest pain.
- Episodes last approx 10 minutes at a time.
- Episodes occur more when lying flat.
- Episodes have been occurring for last 4 months.
- Had a negative stress test & normal GI workup.
- Denies any drug use of cocaine or other medications.
- Quit Smoking 4 months ago. No other past medical history.
- Father had some cardiac problems when he was in his 50s or 60s —— history unclear.

**48 y/o male has crushing chest pain**

**Calls 911**

- Door to PCI time = 49 minutes
  - Initial CK = 72 IU/L, CK MB = 1.0 ng/ml
  - Troponin = < 0.4 ng/ml
  - 8 hours later CK MB = 2.8 ng/ml, Troponin = 0.58 ng/ml
  - 12 hours later CK MB = 3.3 ng/ml, Troponin = 0.51 ng/ml

**Top: three stenosis in RCA & post 3 stents to RCA**

**Bottom: Stenosis in Cx & post stent**

**Pain free on arrival to ED**
- Alert, Oriented
- Skin Warm/dry
- When laid down for EKG developed chest pain
- BP 122/77, HR 87, RR 20 SpO2 99%
- Chest pain 7/10
- Weight: 70 kg
This 12 Lead was done when he was lying down and complaining of chest pain on Feb 24 at 1333.

Patient is SOB & in severe pain at the time of the EKG.

First time EKG done during chest pain.

Chest pain resolved when sat up

BP 118/56, HR 74, RR 20

At 1339 on 2-24 (6 minutes later), the chest pain was gone. Pt was sitting up at the time. This is the 12 Lead EKG.

Serial troponin levels & lipid levels ordered

- Troponin < 0.4 ng/ml
- CK = 71
- Total Cholesterol = 161
- Triglycerides = 66
- HDL = 35
- LDL = 113

Called cardiologist

1st EKG STEMI that resolved after a few minutes.

Admit patient to CVICU. Started on ASA, plavix, heparin drip, nitroglycerin drip, and lopressor

Hold cardiac cath for now as pain free with normal EKG

Cardiac Cath Feb 25
Initial Injection of RCA
Cardiac Cath Feb 25
RCA after administration of Intracoronary Nitroglycerin

- Coronary artery spasm
- Pritzmetal Angina

Management

- Diltiazem 180 mg
- Nitroglycerin 0.4 mg Transdermal patch. Apply at bedtime and remove at 10 am.
- Two days later, stated, “I am finally sleeping at night!”
- Discharged with
  * Diltiazem 180 mg daily
  * Nitroglycerin 0.4 mg Transdermal patch at HS
Quick Review

When you see this...

Activate STEMI team STAT!

In Summary....

When you see this....

Activate STEMI team STAT!

Time is Muscle

59 minutes Door to PCI Time!
Benchmark < 90 minutes

Tackling the Intimidation of the 12 Lead EKG

cherrmann@frontier.com
www.cherylherrmann.com