12-lead and ACS Review

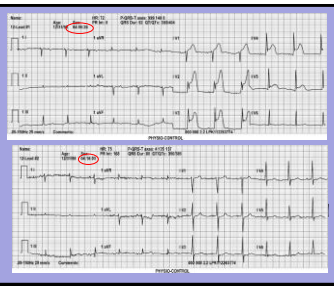
North Lyon Refresher

Part One Objectives

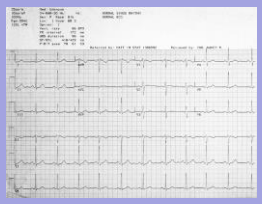
- 12 lead ECG Basics
- Anatomy and Physiology
- STEMI Diagnosis
- Types of MI
- ACS Review
- STEMI System and Interventional Cardiology Review

The Value of 12-Leads

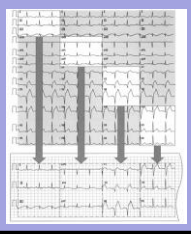
- Important for detection
- Crucial for treatment of ACS
- Pre-hospital Class I indication
- Destination Choices
- Determines extent of treatment

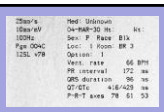


In Hospital 12-Lead ECG



12-Lead ECG





What The…

- Ventricular Rate
- PR Interval
- QRS Duration
- QT/QTc
- P-R-T Axes

- Paper Speed
- Calibration
- Frequency Response

Don't Worry About It…

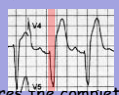
All done for you…

- Paper Speed
  25 mm/sec
- Calibration
  1 mv charge over 20 ms = 10 mm tall Lincoln Hat
- Frequency Response
  0.5-150 Hz

More Advanced Topics to come…

- QT/QTc
- P-R-T Axes

You Already Know About



- PR Interval measures the complete atrial electrical cycle and the delay at the AV Node
- QRS Duration measures the time it takes for the ventricles to depolarize

PR and QRS

- Both Used in Rhythm Diagnosis
- Both may be used to help with patient care and diagnosis/typing of MI

- 1st degree HB has PRI> .2 seconds…
- QRS > .12 sec is ventricular…
- If rhythm has no PRI it isn't atrial…

Seconds to Milliseconds

- QRS < 0.12 seconds
- PRI 0.12 – 0.2 seconds

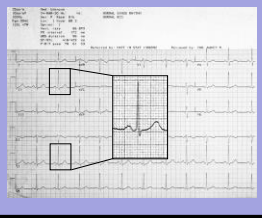
- QRS < 120 ms
- PRI 120-200 ms

To convert seconds to milliseconds move the decimal place over three places.

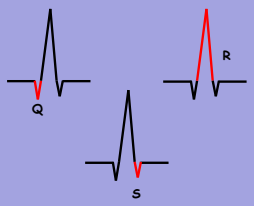
0.120

0.12 seconds = 120 ms

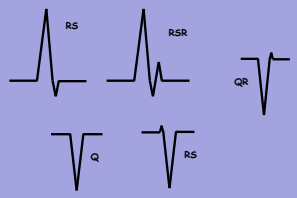
12-Lead ECG



Q R and S Waves

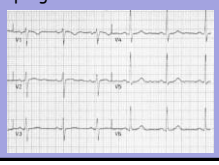


Labeling Waves



R Waves

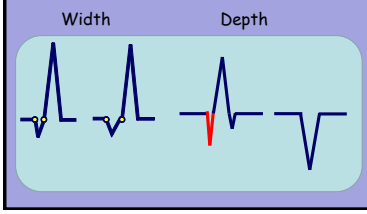
- Dominant and positive in inferior/lateral leads
- R wave progression in V leads



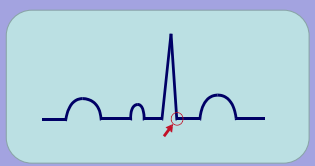
Q's

- Q waves appear in I, III, aVL, aVF, V5, V6
- Q waves are normally 30 ms
  - Physiologic Q waves
    - < .04 sec (40 ms)
  - Pathologic Q
    - >.04 sec (40 ms)
    - Or greater than 1/3 the QRS height

Pathologic Q's Diagnose Tissue Infarction

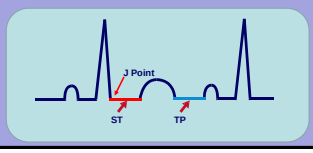


J-Point



ST Segment

- TP segment is truest representation of isoelectric line
- Compare ST (J Point) to TP



AMI Recognition

- What to look for
  - ST segment elevation
    - One millimeter or more (one small box)
    - Present in two anatomically contiguous leads

Contiguous Leads

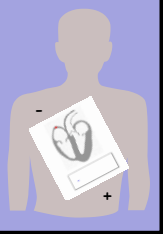
- Leads that come from the same anatomical area (2 or more)
- Numerically consecutive precordial leads are also contiguous
- II, III, AVF (Inferior)
- I, AVL, V5, V6 (Lateral)
- V1, V2 (Septal)
- V3, V4 (Anterior)
- V2, V3 (Anteroseptal)
- V4, V5 (Anterolateral)

ST Segment Elevation

- Presumptive evidence of AMI
- Indication for acute reperfusion therapy

Electrical Flow

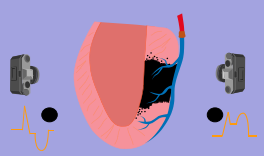
- As Energy flows towards + lead, the tracing is positive
- As energy flows towards negative lead, the tracing is negative



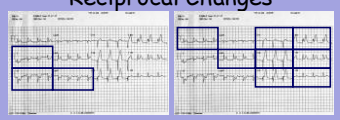
What the lead looks at…

- Think of the positive lead as the "camera"
- It takes a picture of the heart from the angle of the positive lead toward the negative lead

Reciprocal Changes



Reciprocal Changes



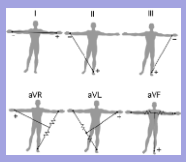
II, III, aVF | I, aVL, V leads

Lead Groups

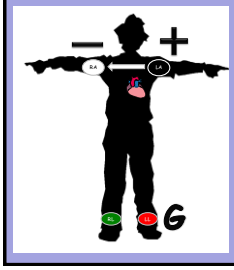
I	aVR	V1	V4
II	aVL	V2	V5
III	aVF	V3	V6

Limb Leads | Chest Leads

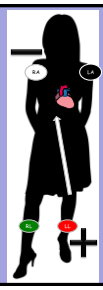
The Limb Leads



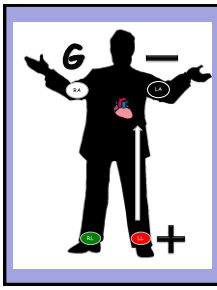
Lead I



Lead II



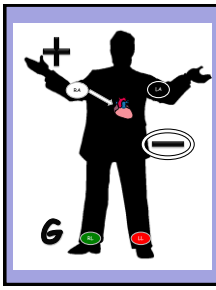
Most likely lead in which to see and interpret QRS



Lead III

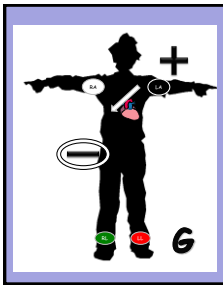
Augmented What??

- Leads that use two negatives to create a new vector
- Augmented Vector Right
  - AVR
- Augmented Vector Left
  - AVL
- Augmented Vector Foot
  - AVF



AVR

- Uses mid point of LA and LL as reference
- Opposite view of Lead II



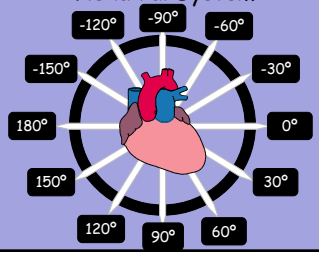
AVL

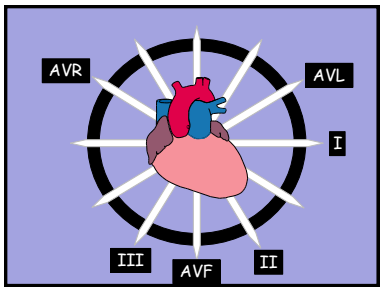
- Uses mid point of RA and LL as reference

AVF

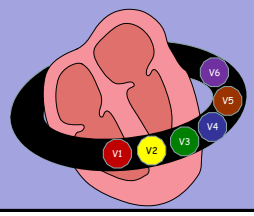
- Uses mid point of RA and LA as reference

Hexaxial System

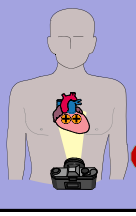




Unipolar Precordial Leads

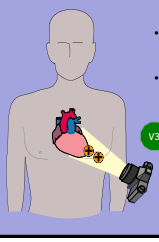


The Septal Leads



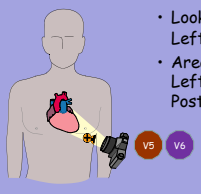
- Look Directly at Ventricular Septum
- Bundle Branches
- AV Node
- Valves
  - Cordae Tendonae

The Anterior Leads



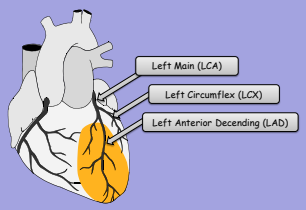
- Look Directly at Left Ventricle
- The pump

The Lateral Leads



- Look Directly at Left Side of Heart
- Area Involved is Left Ventricle and Posterior Muscles

Coronary Artery Anatomy



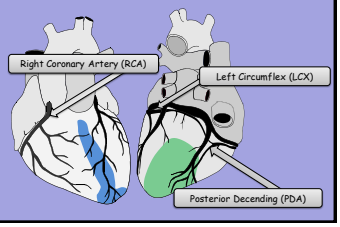
Left Coronary Artery (LCA)

- Left Main (proximal LCA)
- Left Circumflex (LCX)
- Left Anterior Descending (LAD)

Distribution

- LAD = anteroseptal
- LCX = lateral
- Proximal LCA = extensive anterior

Coronary Artery Anatomy



Right Coronary Artery (RCA)

- Proximal RCA
- Posterior descending artery (PDA)

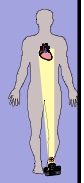
RCA Distribution

- Proximal RCA
  - Right ventricle
  - Posterior wall
  - Inferior wall
- PDA
  - Inferior wall

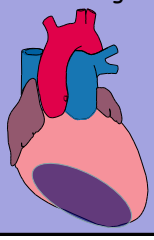
Types of MI's

Inferior

- Lead II, III, AVF
- Transient Conduction Defects
  - 2nd degree type 1
  - Bradycardia
  - 1 degree AVB
- ** 40-60% of these have RV infarct



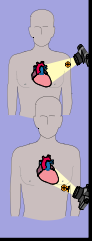
Right Ventricle



- Preload Dependent
- Vasoactive Drugs can have devastating affects
- "Cautious with NTG" vs. NTG by Drip
- Require lots of Fluids

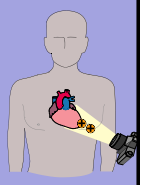
Lateral

- Lead I, AVL, V5, V6
- Usually pretty stable



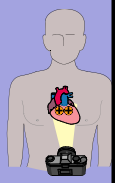
Anterior

- Lead V3, V4
- Permanent Conduction Defects
  - Mobitz 2
  - 3 degree AVB
- Cardiogenic Shock
- VF, VT, SCA

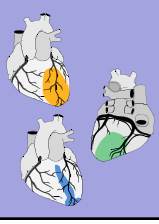


Septal

- Lead V1, V2
- Permanent Conduction Defects
- Causes Valve Rupture
  - Cordae Tendonae
- Bundle Branches!



Extensive Anterior



- Happens when Left Main occludes
- Involves portions of Septal, Anterior, and Lateral parts of Heart
- "Widowmaker"
- Cardiogenic Shock, CABG, SCA, Death

AMI Recognition

- Know what to look for
  - ST elevation
  - > 1mm
  - Two contiguous leads
- Know where you are looking

The Three I's

- Ischemia
  - lack of oxygenation
  - ST depression or T inversion
- Injury
  - prolonged ischemia
  - ST elevation
- Infarct
  - death of tissue
  - may or may not show in Q wave

AMI Recognition

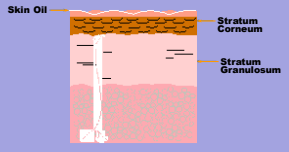
- Reciprocal changes
  - Not necessary to presume infarction
  - Strong confirming evidence when present

Getting the Perfect 12-Lead

Remove Excess Hair

- Clippers or Razor

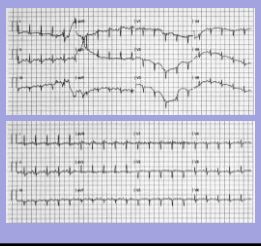
Skin Prep

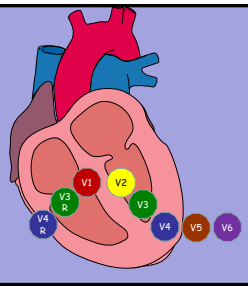


Skin Prep Objectives

- Remove excess hair
- Remove excessive skin oils
- Remove portions of the stratum corneum
- Scratch the stratum granulosum

Skin Prep





Chest Lead Placement

- V1-4th IC right of sternum
- V2-4th IC left of sternum
- V3-Between V2 & V4
- V4-5th IC mid-clavicle
- V5-Horizontally level with V4, anterior axillary
- V6-Horizontally level with V4/V5, mid axillary

Alternate Placement

- The Right Ventricle isn't looked at on the normal 12-lead
- With Inferior MI suspect RVI

Posterior Wall MI (PWMI)

- Usually an extension of an inferior or lateral MI
- Common with proximal RCA occlusions
- Occurs with LCX occlusions

Posterior Wall MI (PWMI)

- Reciprocal changes
  - V1 - V4
- Indicative changes
  - V7, V8, V9

Posterior Leads

- V7
  - Posterior axillary line
  - Level with V6
- V8
  - Mid-scapular line
  - Level with V6
- V9
  - Left para-vertebral
  - Level with V6

PWMI

- Best to identify with direct leads
- V7, V8, V9
- ST elevation in posterior leads is evidence of posterior MI

Acute Coronary Syndromes and Interventional Cardiology

Oxygen

- 4 lpm nasal cannula if respiratory rate normal and $Sa0_2$>95
- High flow mask if hypoxia or tachypnea are evident or suspected
- Advanced airway care for continued or severe hypoxia

12-Lead ECG

- Obtain and transmit with the first set of vital signs
- Repeat with each set of vital signs
- Repeat as often as necessary

Aspirin

- 160-325 mg - chew or swallow
- Only absolute contraindication is known hypersensitivity to ASA
- Issues:
  - Asthma patients may have been told to avoid ASA
  - Patients on anti-coagulants
  - Taken ASA already today

Nitroglycerin

- Dilates conduit arteries
- Antagonizes vasospasm
- Improves collateral circulation
- Inhibits venous return
- Reduces intramyocardial wall tension

NTG Precautions

- Avoid hypotension
- Limit systolic drop
- Don't use NTG as an analgesic
- Watch for RVI

Morphine

- 2 - 4mg every 5 minutes PRN
  - May require several doses for adequate relief of pain
- Decreases myocardial oxygen requirements
- Watch for respiratory depression and hypotension

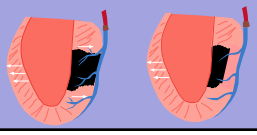
Acute Coronary Syndrome

A continuum of these 3 disease processes

- Unstable Angina
  A change in the pattern of chest pain
- Non Q-wave Myocardial Infarction
  S-T elevation
- Q-wave Myocardial Infarction
  S-T elevation & Q wave

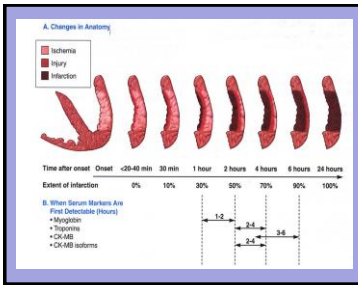
QMI vs. NQMI

- Presence of pathologic Q wave?
- Both produce tissue necrosis
- Q wave MI tends to produce more tissue necrosis (larger MI) than NQMI

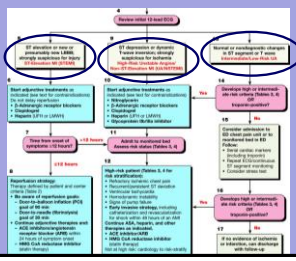


ACS Initiating Events

- Plaque Rupture
- Clot Formation
- Vasoconstriction



Classify Patients within 10 min of arrival…



Time From Onset of Symptoms

How is "onset of symptoms" defined?

- Continuous, persistent discomfort that prompted the patient to seek medical care
- Is more difficult to determine if symptoms are intermittent

Why the division <12 hrs & >12 hrs

- Significant benefit occurs if therapy is initiated <12 & best if <3 hrs
- If pain & ST elevation are still present >12 hrs therapy may still be indicated

12 Lead Interpretation

Part II

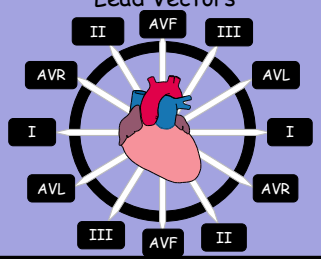
Objectives

- Review Part I
- Imitators
- Axis, QTc
- Rhythms
- Putting it all together

What do the Leads Look At?

- Bipolar Limb Leads
  - I, II, III
- Augmented Limb Leads
  - aVR, aVL, aVF
- Unipolar Precordial Leads
  - V1, V2, V3, V4, V5, V6

Lead Vectors



"Problem 12-leads"

- There are several imitators of AMI that produce or hide ST elevation
- There are a few types of rhythms where MI localization is not precise

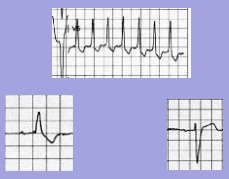
Imitators of MI

- BBB
- Ventricular Rhythms
- LVH
- BER
- Vent Aneurism
- Pericarditis
- Medications

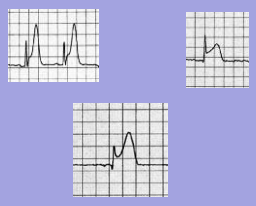
Objectives

- Identify impostors vs. STEMI
- Discordant vs. Concordant
- GUSTO vs. HERO
- STEMI vs.
  - LVH
  - BBB
  - Paced and Ventricular
  - BER and Pericarditis

Discordant QRS-ST-T



Concordant QRS-ST-T

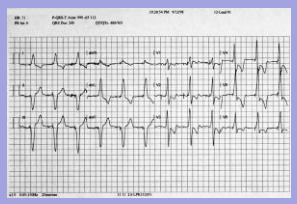


Ventricular Rhythms

- Can mask or mimic every ECG change suggestive of ACS

Paced rhythms
Idioventricular rhythms
AIVR
V-Tach
PVC

Ventricular Rhythms



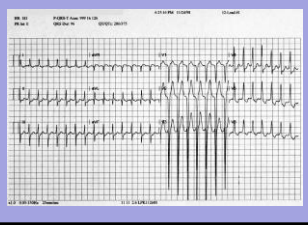
Left Ventricular Hypertrophy

- Can mask or mimic every ECG change suggestive of ACS
- Enlarged left ventricle
  - Pumping against increased resistance
  - Chronic overfillin

LVH

- May Produce
  - ST elevation
  - ST depression
  - Tall T waves
  - Inverted T waves
- May Hide
  - ST elevation
  - ST depression
  - Tall T waves
  - Inverted T waves

LVH



LVH

- Does not abnormally widen QRS
- Increases height and depth of QRS
  - Recognized by this increase
  - Three step recognition formula

LVH Recognition

- Step 1
  - Look in V1 and V2
  - Pick the deepest negative deflection
  - Count small boxes of negative deflection in that lead
  - Remember that number

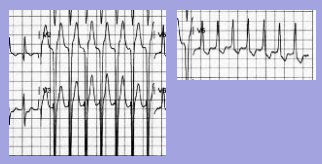
LVH Recognition

- Step 2
  - Look in V5 and V6
  - Pick the tallest positive deflection
  - Count small boxes of positive deflection
  - Remember that number

LVH Recognition

- Step 3
  - Add the two numbers together
  - Suspect LVH if the sum equals 35 or more

LVH



STEMI and LVH

- LVH normally produces discordance

STEMI vs. LVH

- When voltage criteria is met…
- When ST elevation is present in contiguous leads…
- Suspect STEMI if ST elevation is concordant

Bundle Branches

- Right and Left
- Left further divided
  - Anterior Fascicle
  - Posterior Facicle
- Why are Bundle Branch Blocks Bad?

BBB Recognition

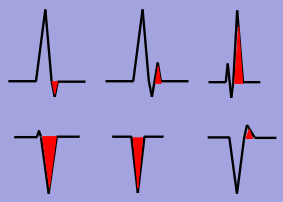
- Wide QRS
  - ≥ 120ms
- Supraventricular rhythm

BBB Recognition

RBBB vs. LBBB

- Use V1
- Identify direction of terminal force
- Terminal force is the last wave of the QRS

Terminal Force



Sgarbossa GUSTO 1 trial

- Of 26,003 MI patients, 131 had LBBB as well (0.5 %)
- Scoring Scale developed from 0 to 5 for predictability of AMI
- Resulted in high specificity, but low sensitivity

– Sgarbossa et al NEJM 1996

Wong et al and HERO trial

- Of 297,832 patients 6.7 % had LBBB (n = 19,467)
- Refined criteria for predicting RBBB and LBBB in presence of AMI
- Resulted in high sensitivity and specificity for 2 of 3 criteria

– Wong et al J Am Coll Cardiol 2005

What's all the fuss about LBBB

- When caused by AMI
  - Causes pump failure and CHF
  - Highest mortality rate of any MI
  - Most Complications
  - Requires extensive Interventional Cardiology and in many cases requires CABG

LBBB vs. STEMI

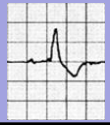
- Concordant ST elevation in any lead
  - 92% probability of STEMI
- Concordant ST depression in V1, V2, or V3
  - 88% probability of STEMI
- Discordant ST elevation > 5mm
  - 50% probability of STEMI

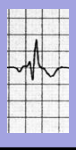
Combinations

- Concordant ST elevation with ST elevation > 5mm
  - 98% probability of STEMI
  - But only 36% of STEMI's had that criteria

RBBB vs. STEMI

- When pt has RBBB…with ST elevation
- Suspect STEMI if ST elevation is concordant with direction of terminal force of QRS





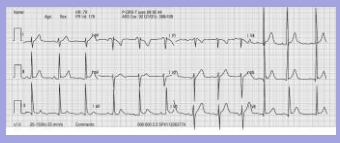
BBB

- May be old
- If not proven to be old, assume it is new
- If story and risk factors suggest MI, treat new or assumed to be new BBB as ST elevation
- If possible…seek most recent ECG

STEMI and Paced Rhythms

- Use HERO criteria but order changes
- Most predictive is ST elevation > 5 mm
- Next most predictive is Concordant ST elevation

Benign Early Repolarization



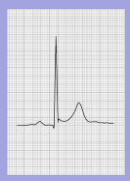
Benign Early Repolarization

- Normal variant
- Produces
  - ST elevation
  - Tall T waves

Benign Early Repolarization

- Changes usually seen in anterior and lateral leads
- Most often seen in males ages 20-40
  - African males
  - Anaerobic Athletes

Benign Early Repolarization



Pericarditis

Pericarditis

- May be viral, bacterial or metabolic
- Clinical presentation may include chest pain
- Often produces ST elevation on ECG

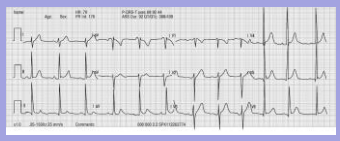
Pericarditis

- May produce ST elevation in any lead
- May be in all leads
- May not be anatomically grouped
- J-point notching often present
  - Fish hook

BER and Pericarditis

- Both produce concordant ST elevation!!
- Both do not produce reciprocal changes
- If reciprocal changes are present, STEMI probability is HIGH

Benign Early Repolarization



Not STEMI, No reciprocal changes

Pericarditis

Not STEMI, No reciprocal changes

Ventricular Aneurysm

- Can mask or mimic every ECG change suggestive of ACS
- NOT Aortic Aneurysm
- "Bleb" in ventricle secondary to infarct
  - Bleb is dyskinetic
  - "Pops out" when ventricle contracts

Ventricular Aneurysm

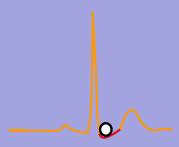
Ventricular Aneurysm

- Associated with persistent ST elevation
  - Often in V1-V4
  - Can occur in any lead

Medications

- Some medications affect the ECG
- Digitalis
  - ST depression
  - Characteristic sag

Digitalis Effect



Remember…

- Most of this is for predicting interventional cardiology success and appropriate destination
- ACS treatment remains targeted at History, Risk Factors, ECG, and Sx

Summary

- Imitators can *produce* ST elevation or depression
- Imitators can *eliminate* ST elevation or depression

Summary

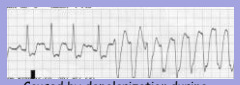
- Imitators can incorrectly place an ECG into any of the three categories

ST Elevation BBB	ST Depression T wave inversion	Normal Non-diagnostic

The presence of an imitator *DOES NOT* rule out an Acute Coronary Syndrome

Some Dysrhythmias

R on T Phenomenon

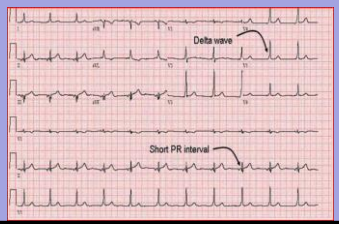


- Caused by depolarization during relative refractory period
- The cells that are ready to depolarize do, and the other ones do when they are ready
- The result is a cascade of depolarizing cells at different times
- Polymorphic VT…

Wolfe-Parkinson-White

- Impulse from SA node bypasses the AV node, goes straight to ventricles
- Early depolarization of Ventricles
- PR less than 120 ms
- QRS < 120 ms with slurred onset
- Lots of Tachydysrhythmias

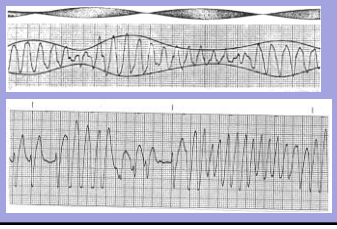
Short PRI causes Delta Wave



Torsades de Pointes

- Associated with prolonged Q-T
- VT with QRS of changing amplitude
- Peaks on top, then on bottom or vice versa
- Really fast >200
- Drug of choice is MAGNESIUM
- Amiodarone prolongs the Q-T

Torsades de Pointes



Hyperkalemia

- EKG Changes
  - 5.5-6.0 Tall Peaked T waves
  - 6.0-6.5 Prolonged PR then lose P wave
  - >6.5 Widening QRS then Death

Consequences of Hyperkalemia

- Sequence of cardiac changes
  - Peaked T wave
  - PR interval grows
  - P wave disappears
  - QRS Widens
  - Asystole in depolarized state

Axis

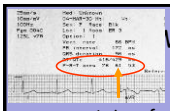
P-R-T Axis Deviation

- Seldom used to it's full benefit
- Most people just don't care about it…

Why do we care?

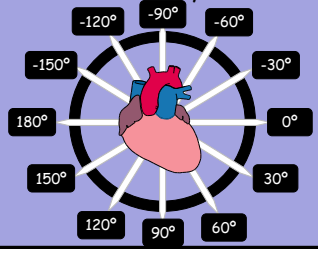
- It can tell you about the pt
  - MI or Hypertrophy
- It can tell you why the waveform is abnormal
- It can tell you where the rhythm came from

What is it?



- Axis refers to the direction of each waveform's electrical conduction
- Three Axis
  - P wave
  - QRS (R)
  - T wave
- We care about QRS Axis…

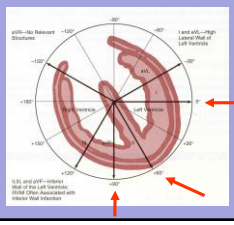
Hexaxial System



Hexaxial Reference System

- The limb leads imposed into a 360° circle
- Divided into positive (0-180) and negative (180-0) sides
- Normal is 0 to +90
  - Average norm is +60

Hexaxial Reference System



Things that cause Right Deviation

- COPD
- PE
- Congenital Heart Disease
- Pulmonary Hypertension
- Cor Pulmonale

Things that cause a Left Deviation

- Ischemic Heart
- Systemic Hypertension
- Aortic stenosis
- LV Disorders (Hypertrophy)
- Aortic Valve Disease
- WPW
- Lyme Disease

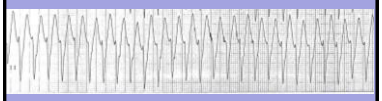
Axis Changers (That we care about)

- Hypertrophy
- Infarct
- Bundle Branch Blocks

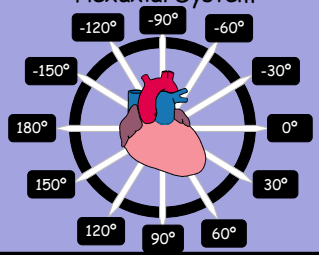
BBB

- LBBB is Dx with QRS > 120 ms and negative terminal force in V1 (Bifascicular)
- RBBB is Dx with QRS > 120 ms and positive terminal force in V1
- RBBB with LAFB is when axis is deviated left
- RBBB with LPFB is when axis is deviated right

V-Tach or Aberrant SVT???



Hexaxial System



Thanks to:

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ecgsolutions.com

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Questions?

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