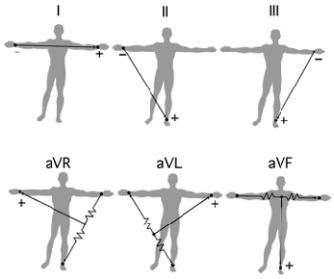
Electrocardiography (ECG)

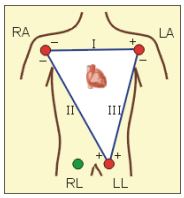
Principles of ECG recording & description
Interpretation of the most common ECG pathologies

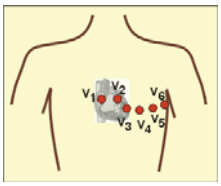
Standard ECG recording



- 12-lead ECG
  - 3 bipolar limb leads I, II and III
  - 3 unipolar "augmented" limb leads aVL, aVR, aVF
  - 6 unipolarních precordial leads V1 – V6

Placement of electrodes

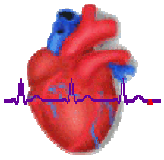




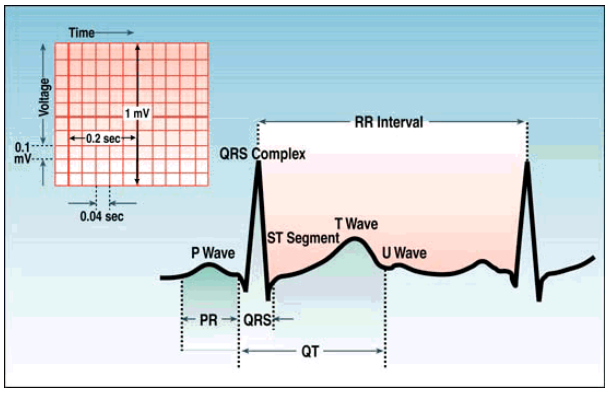
- limbs
  - right upper limb
  - left upper limb
  - left lower limb
  - right lower limb
- chest
  - 4th intercostal space right parasternally
  - .....
  - 5th intercostal space in middle axillar line

Electrocardiogram (ECG)

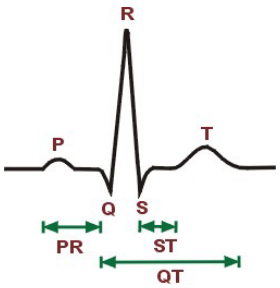
- record of potential changes over the time course
  - potential changes results from periodical depolariasation followed by repolarisation of the myocardium
    - this produces electrical field measurable by electrodes placed on the body surface
- morphology of the ECG curve is a sum of instantaneous el. vectors



ECG curve



Description of ECG - algorithm

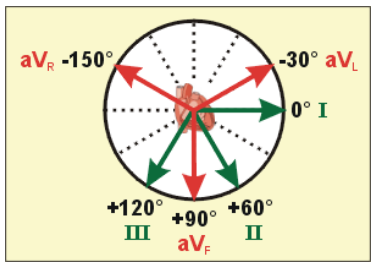


1. rhythm
   a. pacemaker
   b. regular/irregular
2. frequency
3. el. cardiac axis
4. analysis of individual waves and intervals

Description of ECG

- rhythm
  - sinus
    - the only physiological
    - 60-90/min
  - other
    - junctional
      - 40-60/min
    - idioventricular
      - 30-40/min
    - atrial fibrilation
      - atria up to 600/min
      - ventricules 60-90/min
    - atrial flutter
- heart beat
  - regular
  - irregular
- frequency
  - normal
    - 60 – 90/min
  - tachycardia
    - >90/min
  - bradycardia
    - <60/min

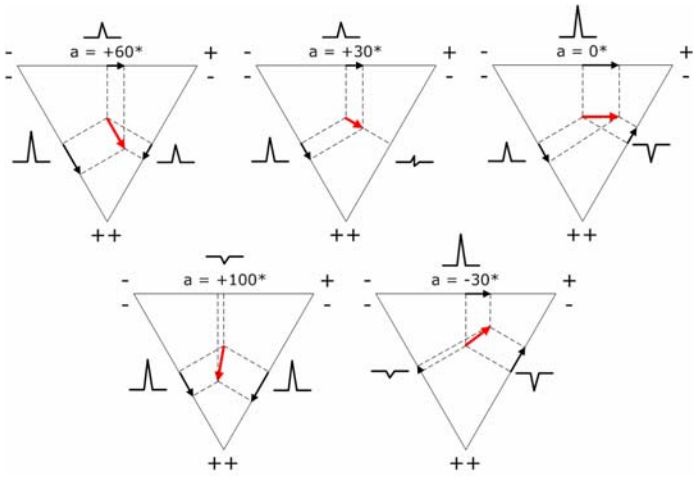
Electrical cardiac axis



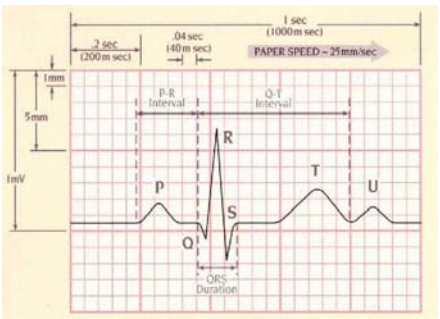
- direction of el. activity during depolarisation of chambers
- normal axis
  - -30 to +105
- pathology
  - ventricular hypertrophy
  - bundle branch block

How to determine el. axis?

- direction of el. axis is conventionally described in frontal level by an angle between al. axis and horizontal line of the Ist lead
  - projection of R in limb leads into Eithoven's triangle



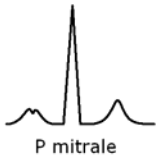
Analysis of waves and intervals



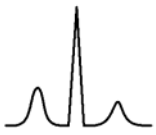
- waves
  - P, T, (U)
- deflections
  - Q, R, S
- intervals
  - PQ (PR)
    - 0.12 - 0.20s
  - QRS complex
    - 0.06 – 0.10s
  - ST
  - QT
  - RR
- amplitude
  - R
  - deep Q

P wave (≤0.1s), PQ interval (0.12-0.20s)

- P wave = atrial depolarisation
  - P absent in:
    - atrial (ventricuar) fibrillation and flutter, SA block, ventricular and supraventricular tachycardia, junctional rhythm
  - P mitrale
  - P pulmonale
- PQ interval = AV conduction
  - normally isoelectric
  - prolonged PQ
    - sign of fitness, digitalis, beta-blockers, myocarditis
  - shortened PQ
    - preexitation, tachycardia



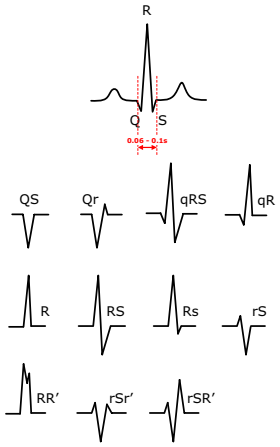
P mitrale



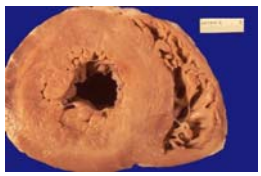
P pulmonale

QRS complex (0.06 – 0.1s)

- depolarisation of chambers
  - wider QRS
    - bundle branch block, ventricular extrasystoles, ventricular tachycardia, idioventricular rhythm
  - pathologic ("deep") Q
    - over the electrically "silent" area of myocardium
      - duration >0.04s, depth>3mm, >1/4 of the following R
    - typically after transmural myocardial infarction
  - pathologic R
    - higher amplitude in ventricular hypertrophy
    - smaller amplitude in obesity, oedema (pericardial, pleural, generalised), emphysema etc.



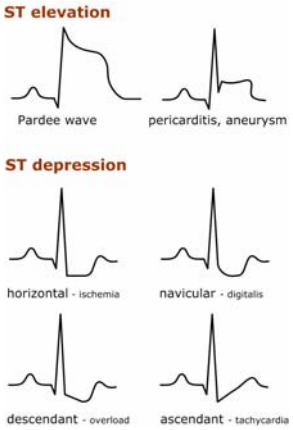
Ventricular hypertrophy – voltage criteria



- "golden standard" method = echocardiography
  - ECG criteria are auxiliary
- Hypertrophy
  - concentric
  - excentric
    - tLV >12mm
    - tRV >5mm
- ECG criteria
  - ↑ amplitude of R
  - el. axis points towards hypertrophic chamber
  - wider QRS (longer depolarisation of hpt. chamber)
  - event. ST-T changes as a sign of overload
- LV hypertrophy
  - **Sokolov's index**
    - $S_{V1,2} + R_{V5,6} \geq 35mm$
  - **index McPhie**
    - $S_V max + R_V max \geq 40mm$
- RV hypertrophy
  - only quite advanced hypertrophy recognisable of ECG
  - voltage criteria + vertical el. axis + event. signs of overload

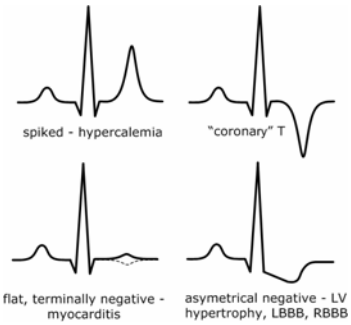
ST segment

- ST + T wave = repolarisation of ventricles
- normally isoelectrical
- ST elevation
  - epicardial damage
    - transmural IM
    - pericarditis
    - aneurysm
    - Prinzmetal angina
- ST depression
  - subendocardial damage
    - ischemia (angina pectoris, non-transmural IM)
  - volume/pressure overload
  - tachycardia

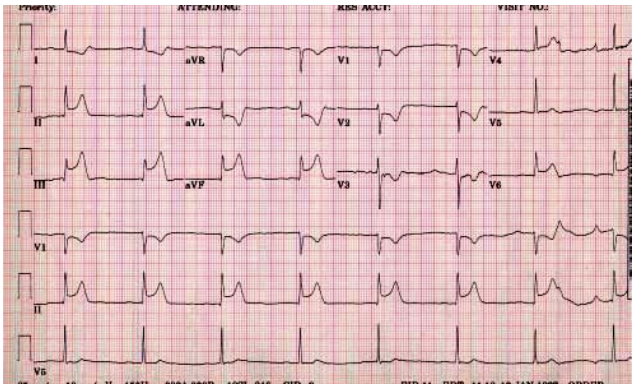


T wave, QT interval (0.32 - 0.42s)

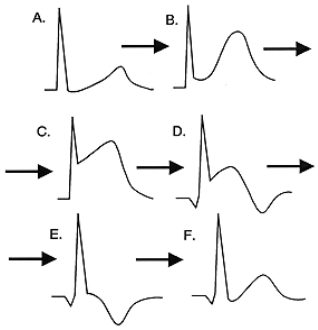
- repolarisation of ventricles
- except of aVR lead usually positive
- pathological T
  - coronary
  - flat
  - spiked
- pathological QT
  - prolonged
    - hypercalcemia, hypocalemia, ischemia, LQTS
  - shortened
    - hypocalcemia, hypercalemia



ECG presentation of AIM



Sequence of ECG changes during transmural AIM



- A. initial physiological curve
- B. super-acute stadium
  - spiked positive T waves (minutes)
- C. acute stadium
  - ST elevation = Pardee wave (minutes to hours)
- D. sub-acute stadium
  - normalisation of ST segment
- E. development of "deep" Q (event. persistent ST-T changes)
- F. chronic stadium
  - persistence of deep Q