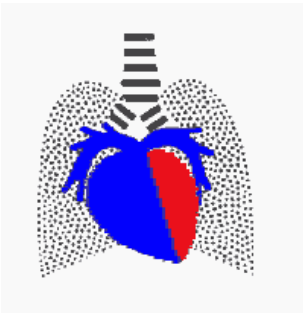


Clinical aspects of the cardiovascular physiology



Milan Chovanec

Department of Physiology, 2. LFUK in Prague
Cardiocenter, Na Homolce Hospital, Prague





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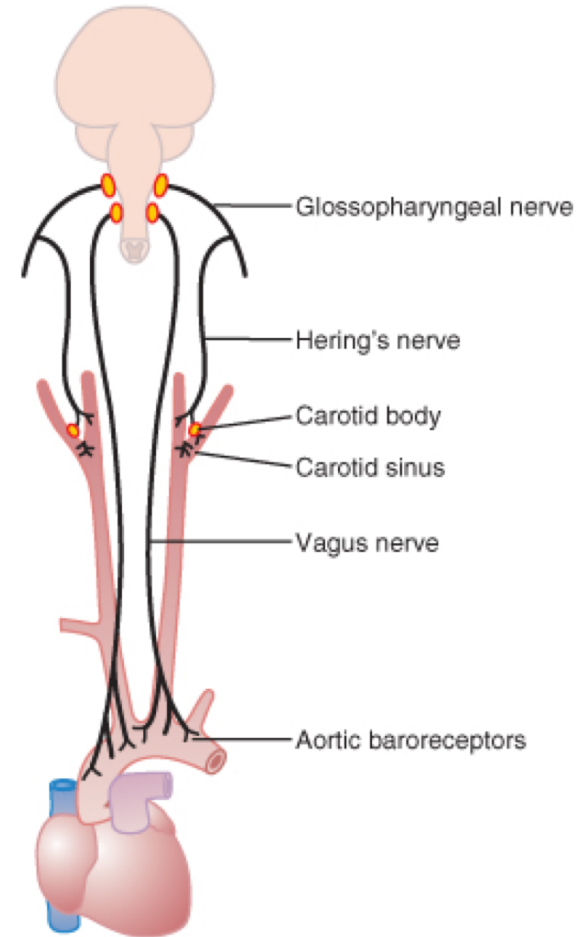
1. Arterial hypertension: regulations, therapy mechanisms
2. Acute myocardial ischemia: STEMI, aetiology, mechanism of origin, therapy mechanisms
3. Acute heart failure, basic approaches to therapy: pharmacological approaches (inotropy, contractility, vasoactive drugs: Dobu, NOR, Adr, milrinon, vazopressin, levosimendan...) + mechanical approaches
4. Conductive system disorders: SA, AV blocks a cardiac pacing
5. Vasovagal syncope: current approach of the treatment
6. Cardiac arrhythmias, reentry mechanism – type of tachycardia (AVNRT, AVRT, VTs....)

Elevated blood pressure – arterial hypertension

- Elevated BP, MAP
- Heart, vessels, kidneys interaction
- BP regulation:
 - Short-term: sympathetic activation
 - Mid-term: RAAS
 - Long-term: kidneys

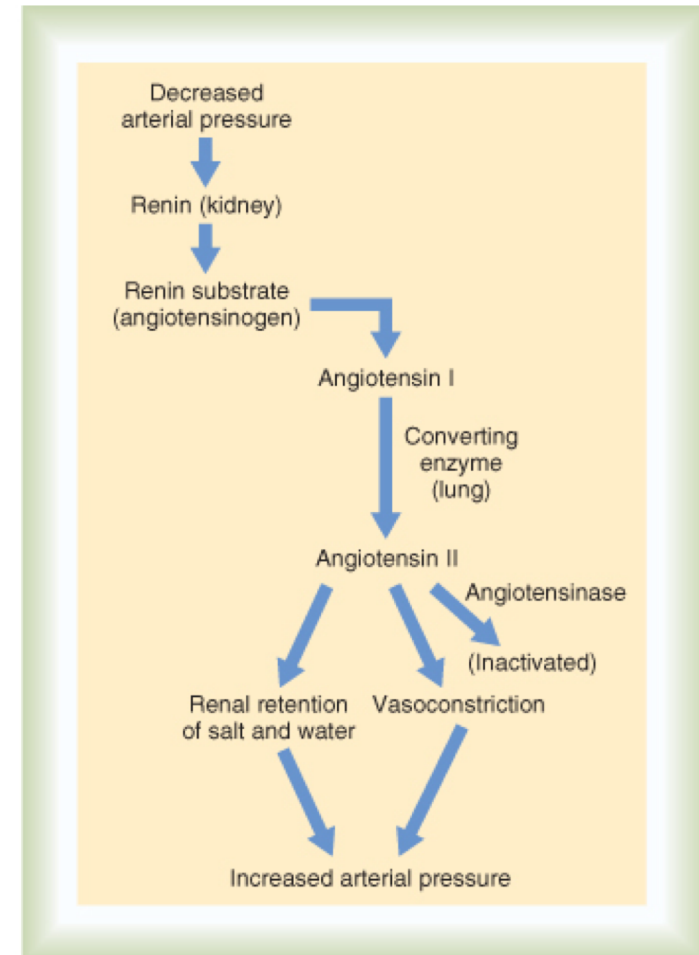
BP regulation – short-term

- Seconds, minutes
- Equilibrium at different BP value
- Sympathetic / parasympathetic, reflex arc
- Effective solution to acute BP changes
- It is not very advantageous from the point of view of long-term BP regulation



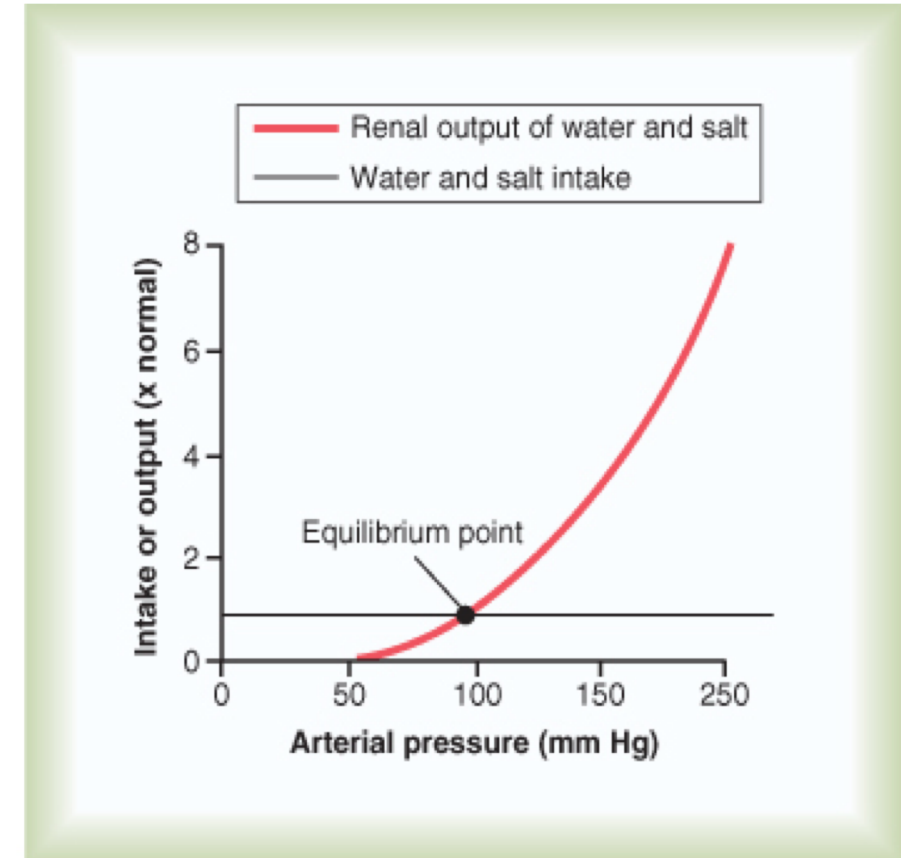
BP regulation – mid-term

- Minutes, hours, days, weeks....
- Renin-angiotensin-aldosteron-system (RAAS)
- A more efficient system in the long run
- It also affects growth factors and the remodeling of blood vessels and the heart, i.e. LV hypertrophy, vessels, collateral circulation.....



BP regulation – long-term

- Days, weeks, months, years....
- Intreraction of CVS and kidneys
- Kidney = pressure valve
- The most effective way of long-term blood pressure regulation
- Changing the patient's lifestyle (low NaCl intake) is essential.....!!!!!!

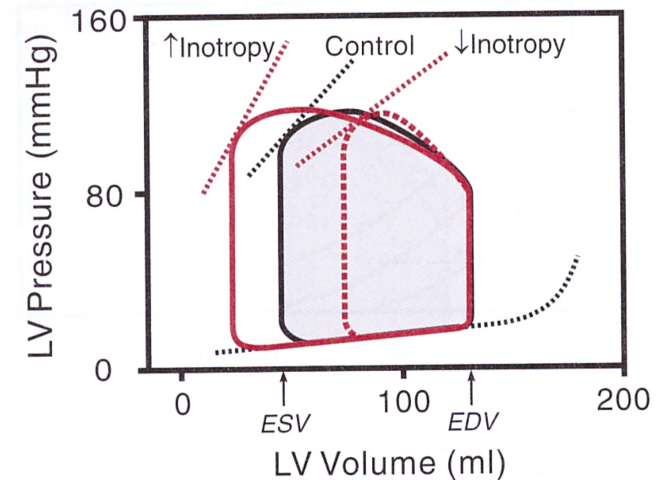
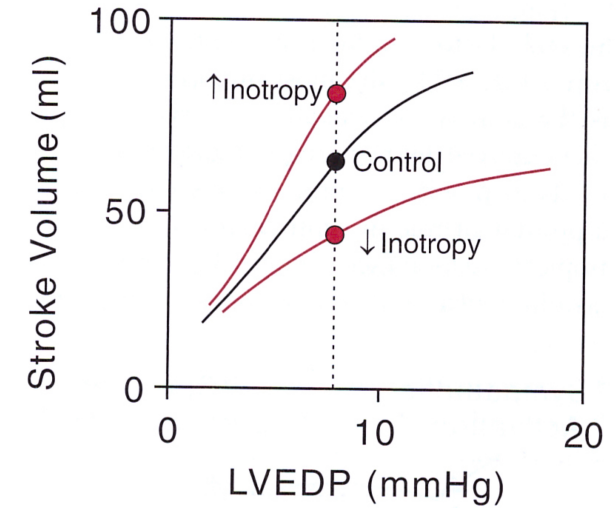
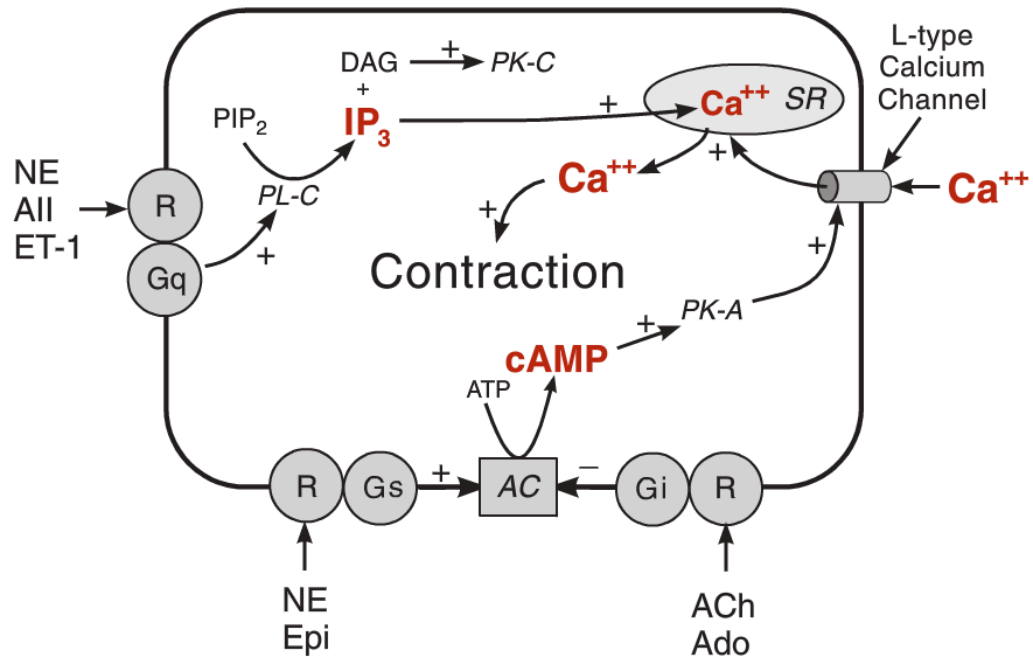


Current treatment options for arterial hypertension

- Betablockers
- ACE inhibitors / AT-II receptor inhibitors
- Ca channels blockers
- Diuretics
- Peripheral antihypertensives
- Central antihypertensives

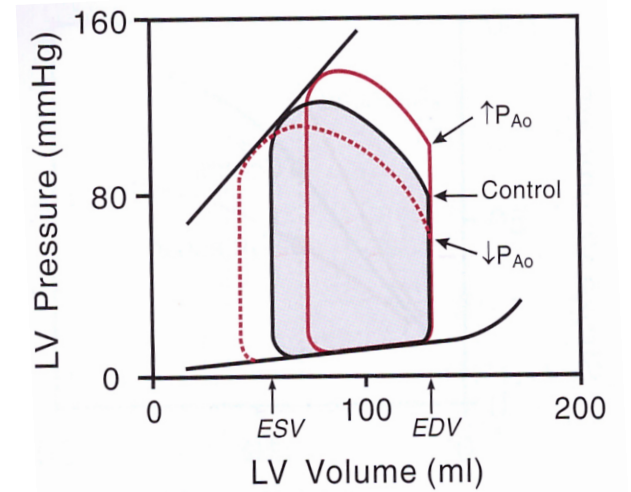
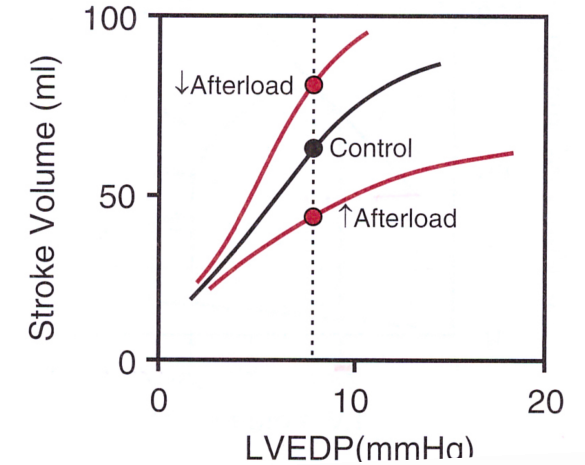
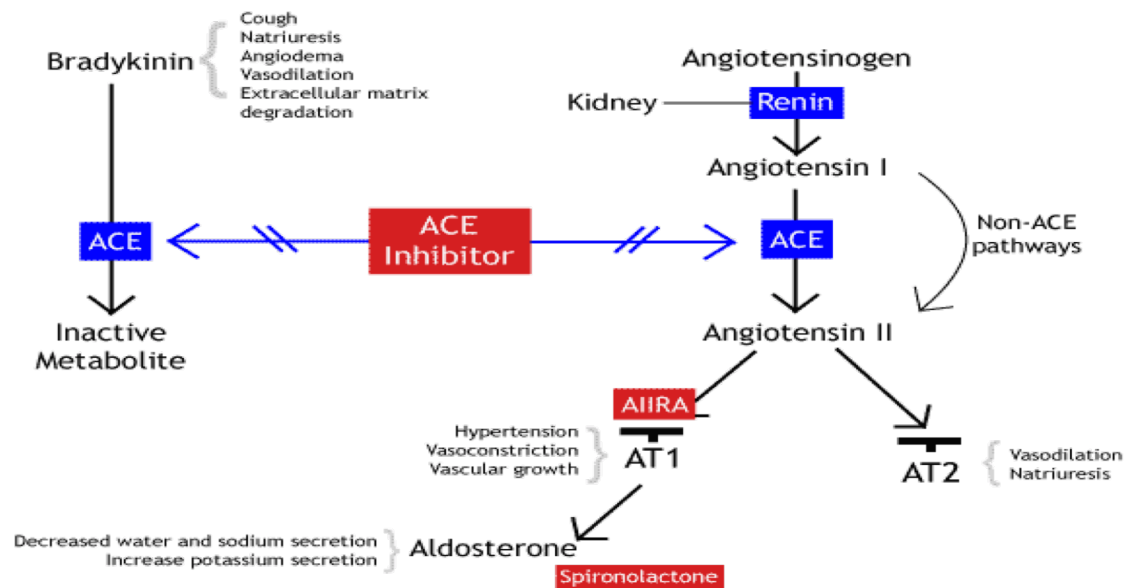
Treatment of hypertension – beta-blockers (cardioselective)

- Sympathetic inhibition (β_1 -receptors) = decrease of ino/chronotropy



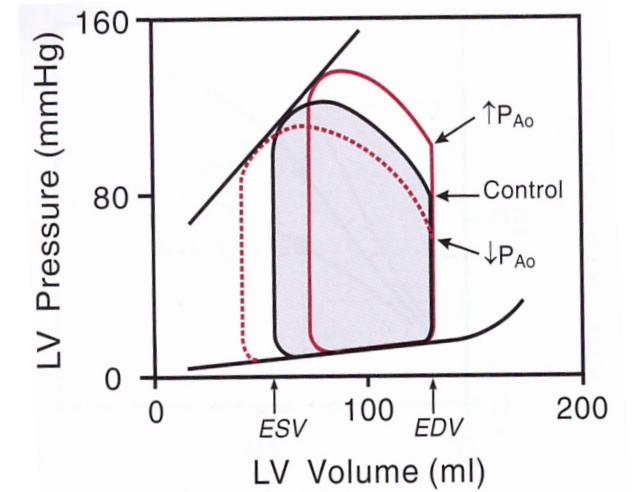
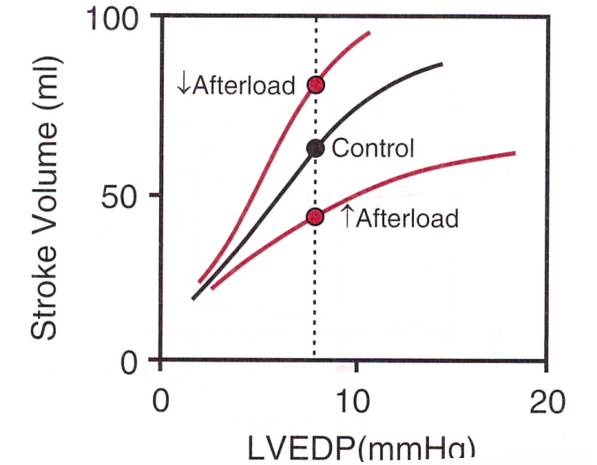
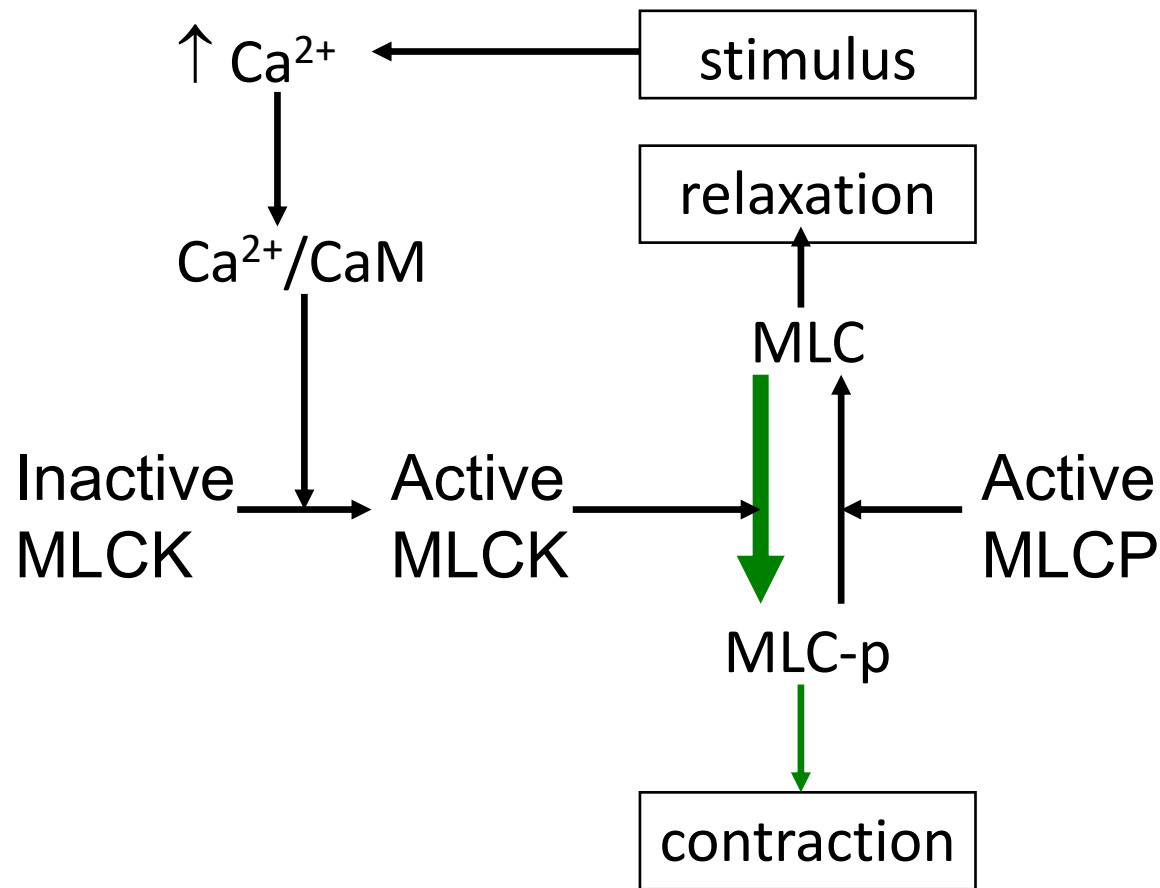
Treatment of hypertension – ACEi /ARB

- Peripheral (arteriolar) vasodilation = decrease of SVR



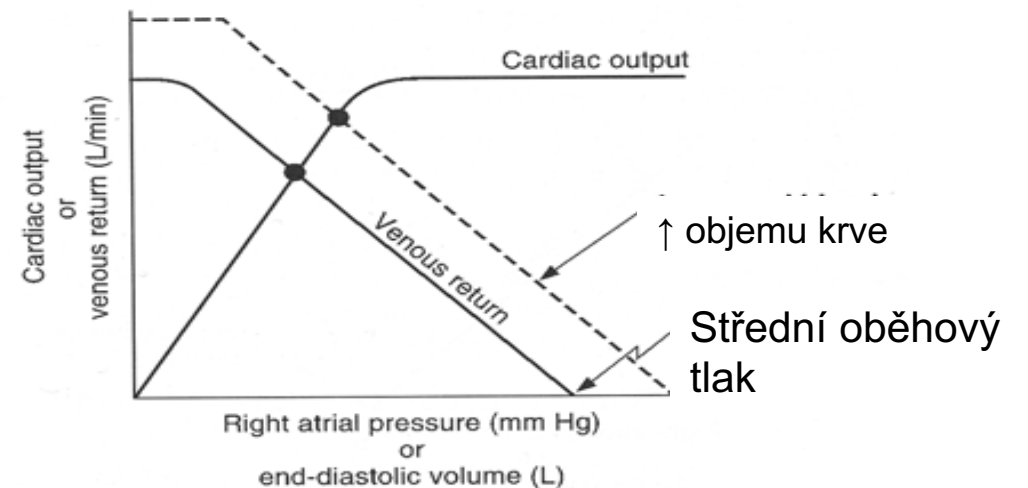
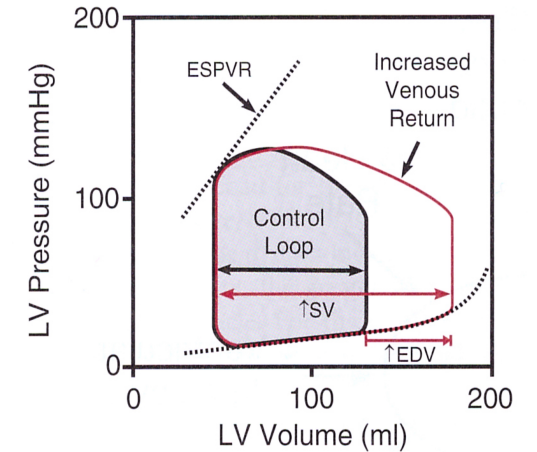
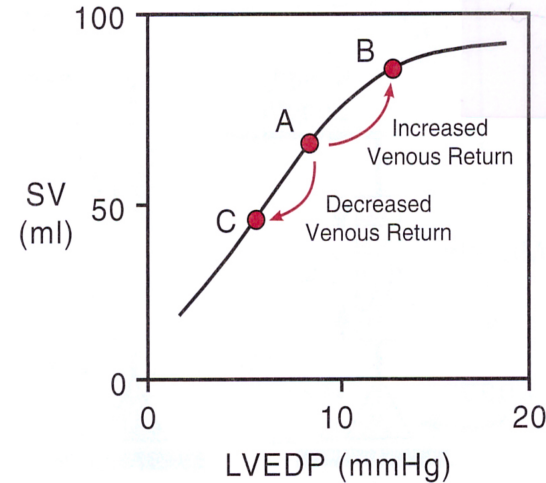
Treatment of hypertension – Ca blockers

- Inhibition of contraction of the arteriolar SMCs – decrease of SVR



Treatment of hypertension – diuretics

- Diuretics = increase water loss in kidneys
- Decreased preload
- Decreased venous return, CVP



Treatment of hypertension – central and peripheral antihypertensives

- Decreased sympathetic activation – central (CNS) vs. Peripheral (vessels)
- Peripheral (vascular) vasodilation
- Decreases SVR
- Decreased inotropy, chronotropy



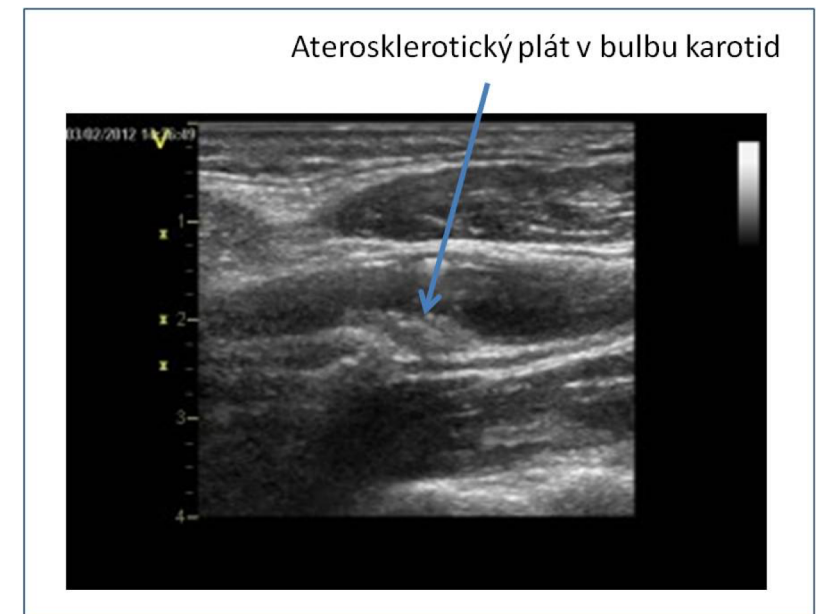
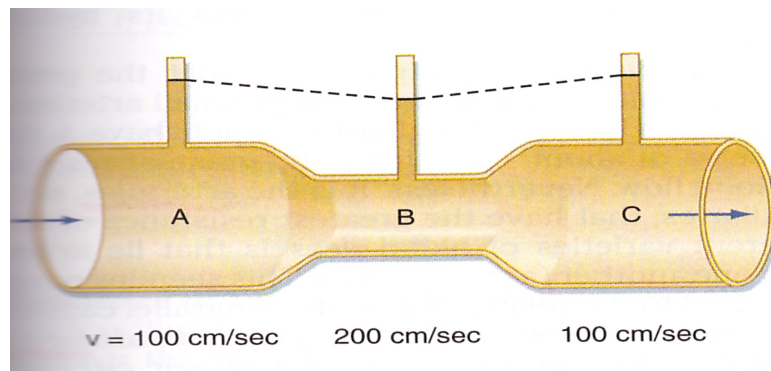
Arterial hypertension - summary



- Inotropy, chronotropy
- SVR, afterload
- Venous return, preload
- Sympathetic / parasympathetic activation

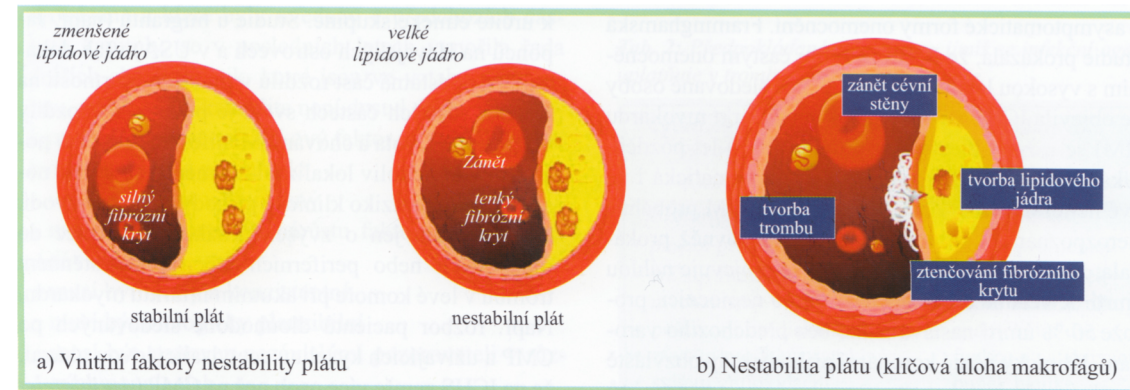
Acute myocardial ischemia

- One of the most common causes of morbidity and mortality in people in the developed world
- It is closely related to the proces of atherosclerosis
- Bernoulli's law: relationship between the kinetic and the potential energy

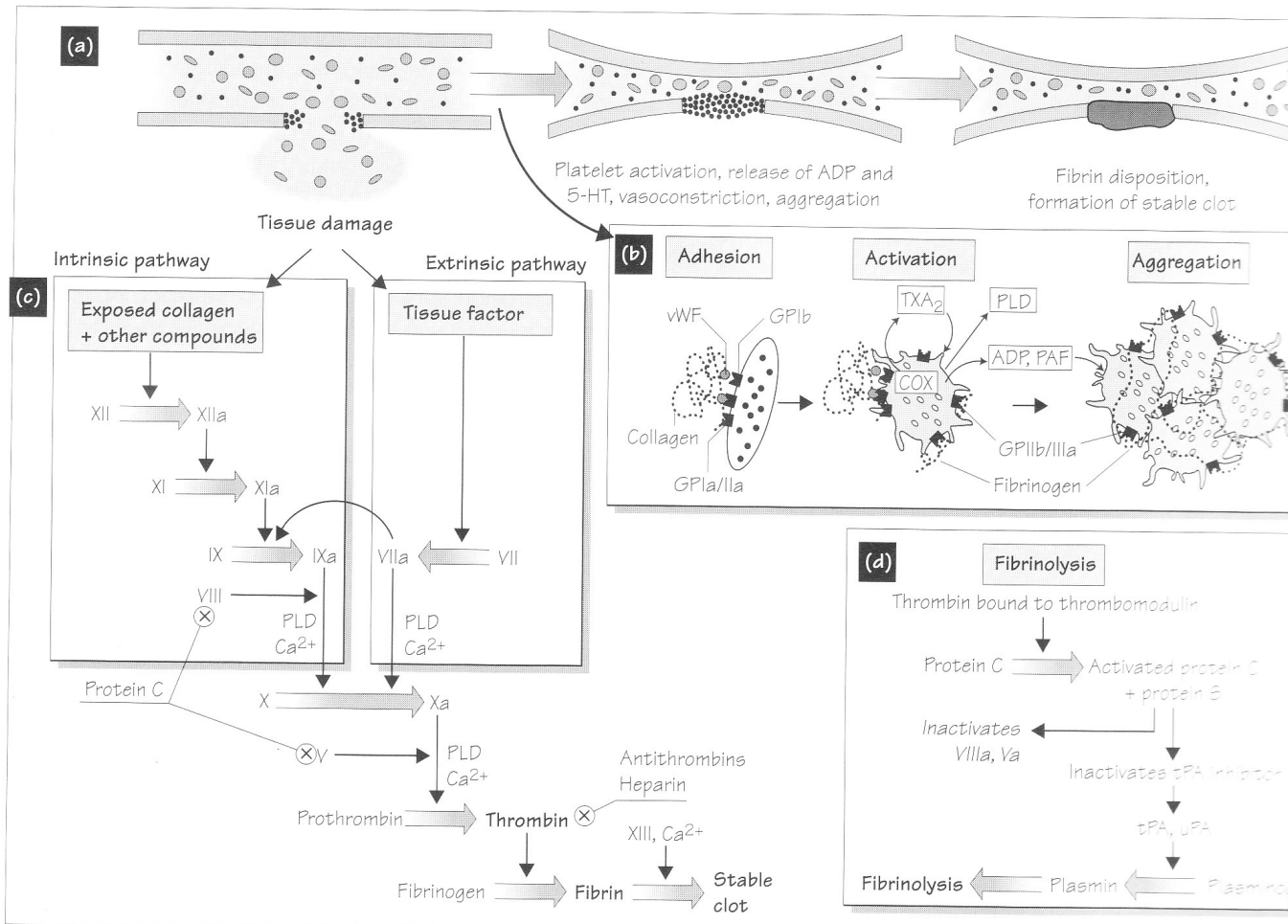


Atherosclerotic plaque rupture

- Exposure of the lipid core of the plaque is thrombogenic
- Platelet activation
- Activation of the coagulation cascade
- Acute vessel occlusion = acute ischemia



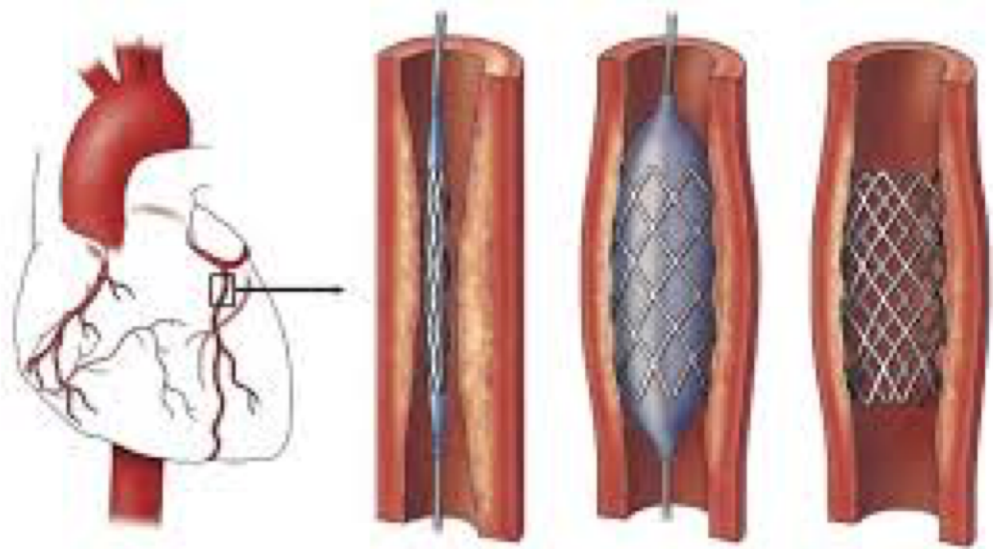
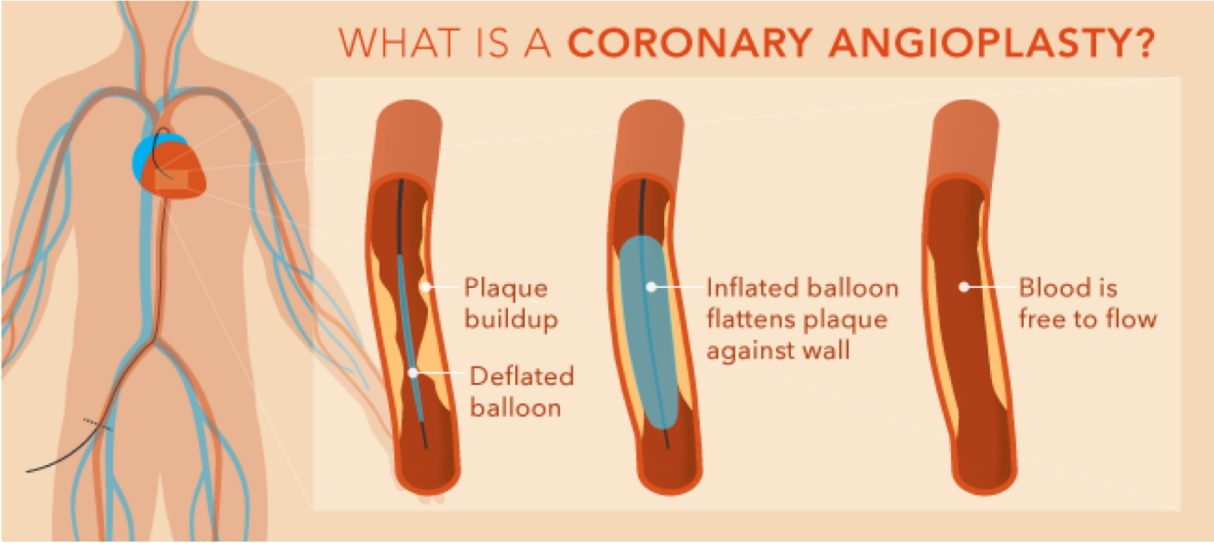
Mechanism of acute vascular occlusion - haemocoagulation activation



Mechanism of acute vascular occlusion – treatment principle

- Inhibition of coagulation processes (antiaggregation, antikoagulation, ...trombolysis)
- mechanical restoration of flow through the vessel

Percutaneous coronary intervention - PCI

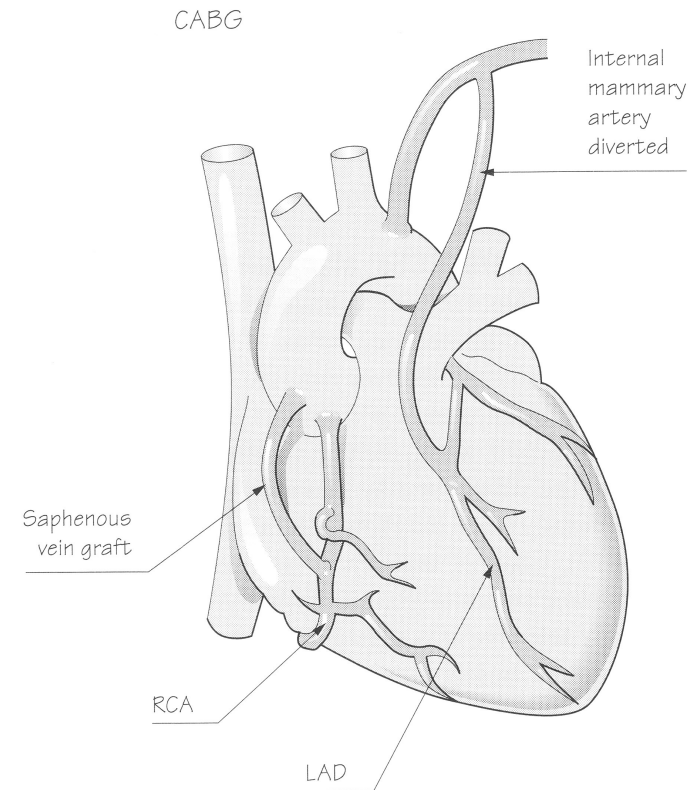
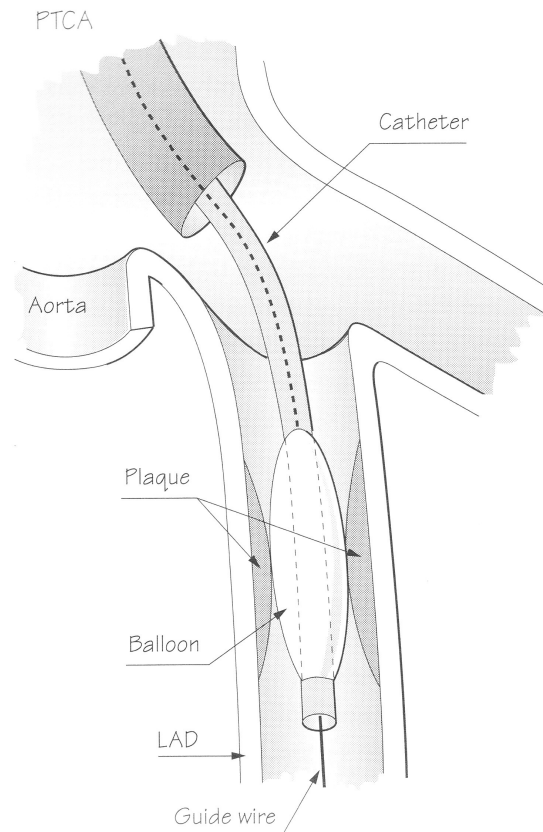


Source: Britannica.com

Mechanical treatment of acute myocardial ischemia

Management

Medical: β -blockers, Ca^{2+} -channel blockers, nitrovasodilators, aspirin, heparin, or
Revascularization:





Acute myocardial ischemia – summary



- The process of atherosclerosis is essential !!!
- Plaque rupture = induction of hemocoagulation
- Hemocoagulation = acute occlusion of a blood vessel
- Treatment principle:
 - Inhibition of hemocoagulation (antiaggregation, anticoagulation, thrombolysis...)
 - Mechanical occlusion of the vessel, PCI

Acute heart failure

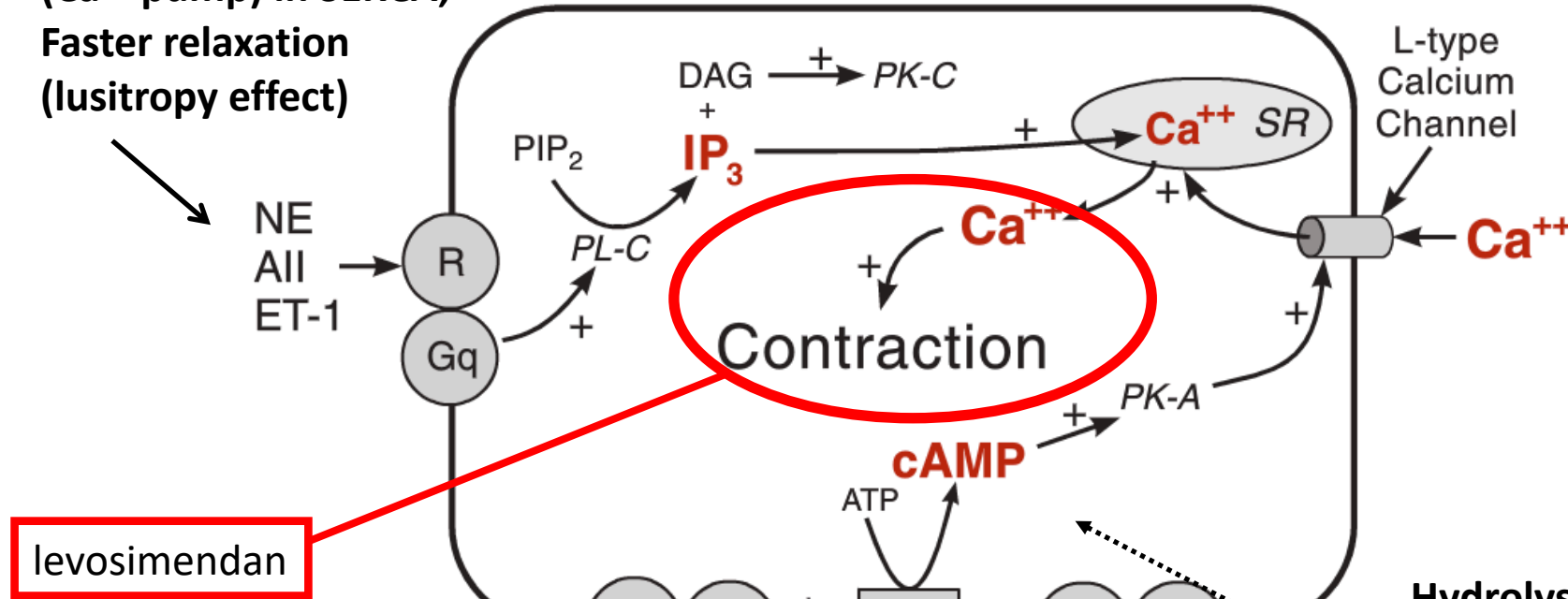
- Acute heart failure = kardiogenic hemodynamical shock
- shock = heart failure
- Heart failure = the heart is unable to pump blood around the body properly (organ needs)
- Aetiology: ischemia, infection, arrhythmia, mechanical injury....

Acute heart failure – treatment principle

- **To treat the cause of heart failure is essential !!!!!!!**
- **Pharmacotherapy:**
 - homeometric regulation of myocardial contraction
 - Increasing SVR thereby maintaining MAP and perfusion of the brain and the heart
 - Heterometric regulation
- **Mechanical treatment:**

Acute heart failure - pharmacotherapy

Phospholamban inhibition
(Ca²⁺ pump) in SERCA,
Faster relaxation
(lusitropy effect)



- A, NOR
- PDE inhibitor
- Vasopressin
- Levosimendan (increased sensitivity to Ca²⁺)

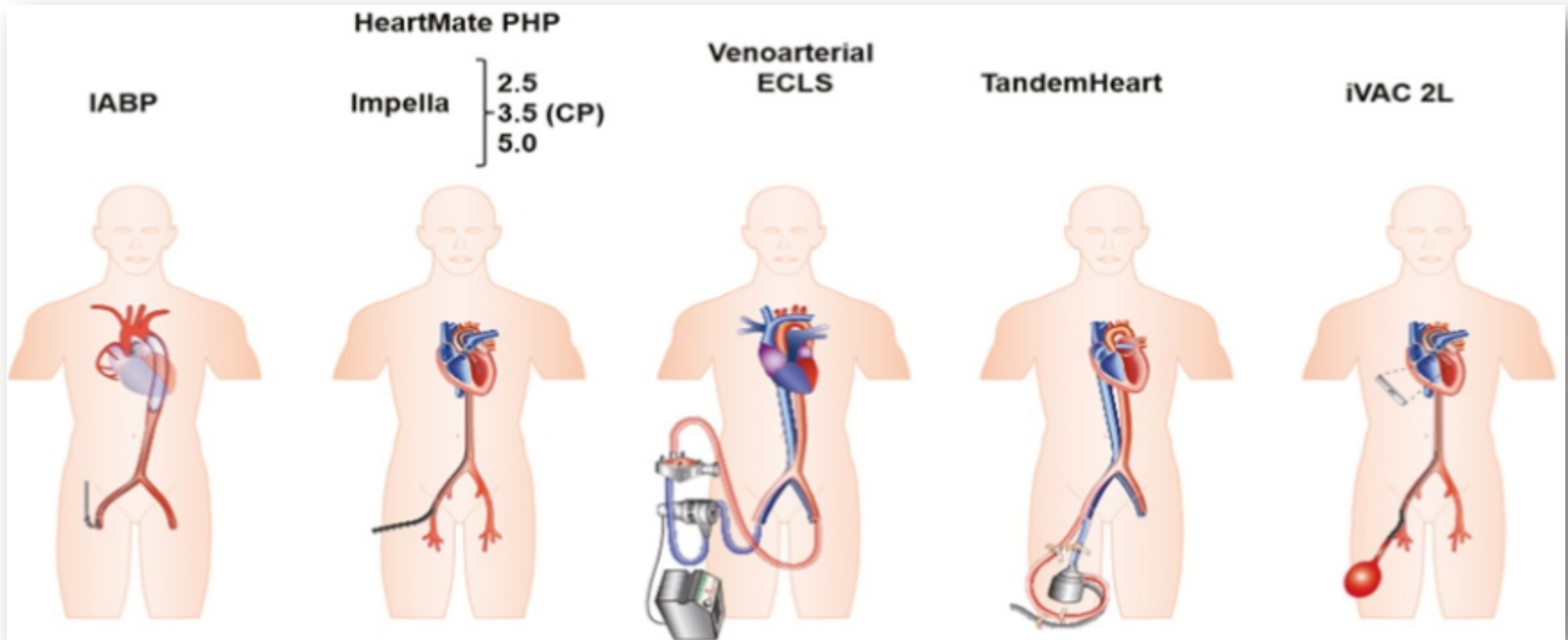
Ca²⁺-channel activation (L-type),
More calcium in the cells

Hydrolysis inhibition
(PDE inhibition),

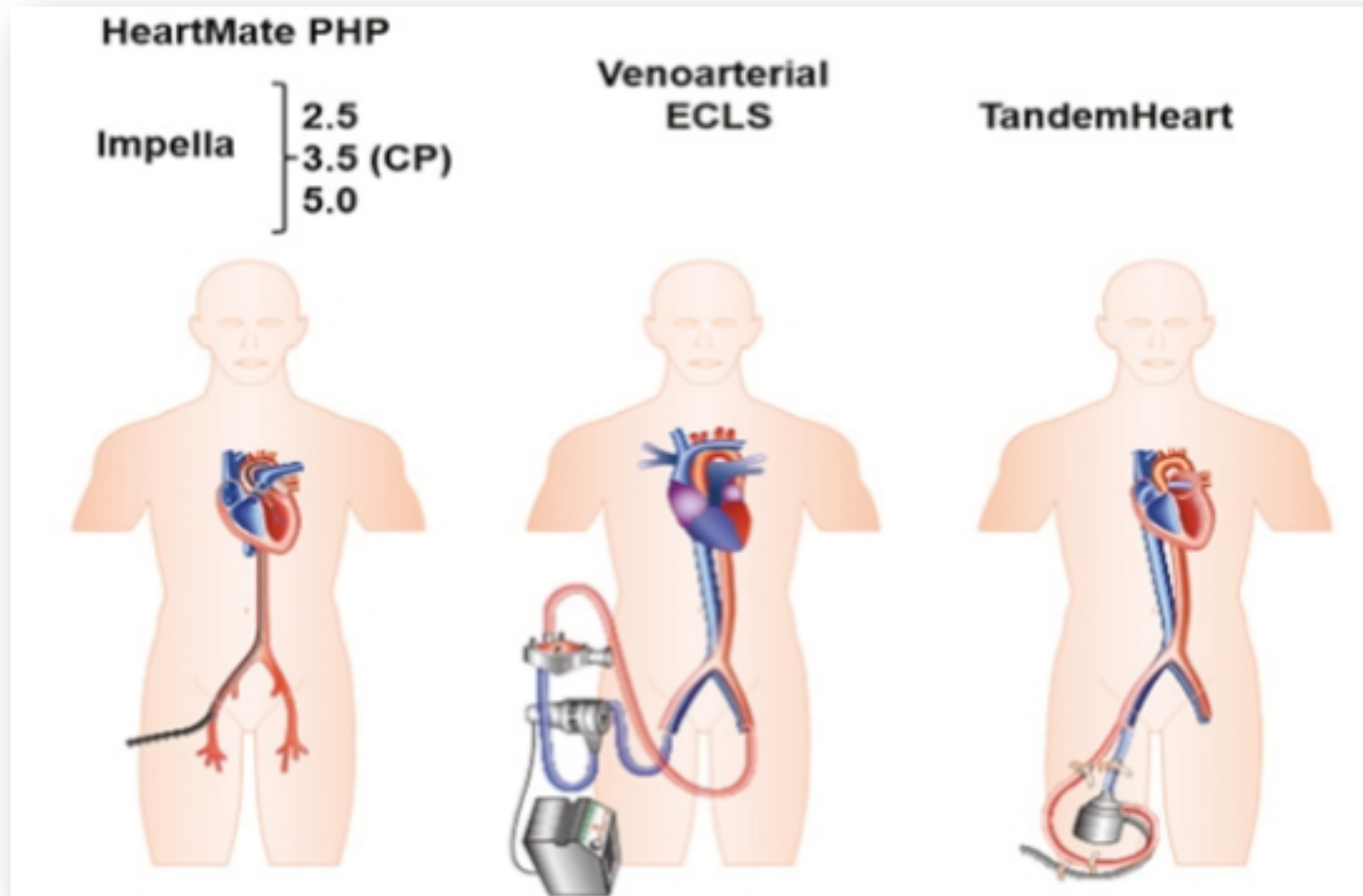
Prolonging the effect
of cAMP

Milrinon (Corotrop)

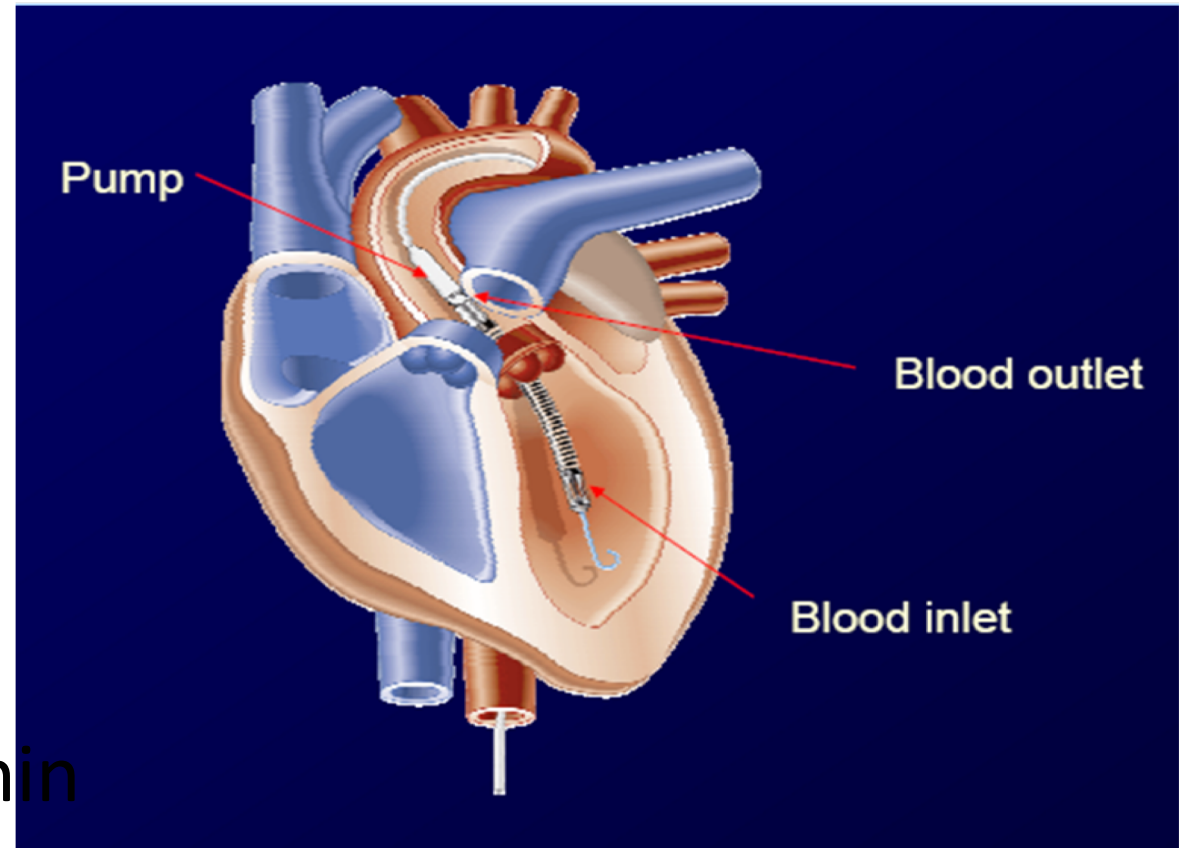
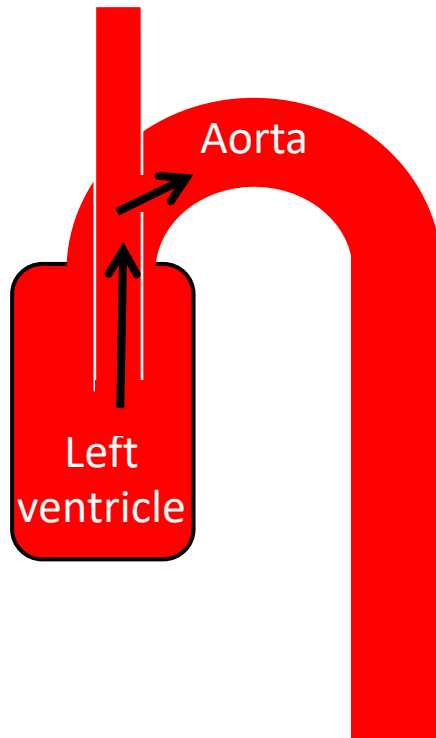
Acute heart failure – mechanical treatment: percutaneous mechanical support



Percutaneous mechanical support



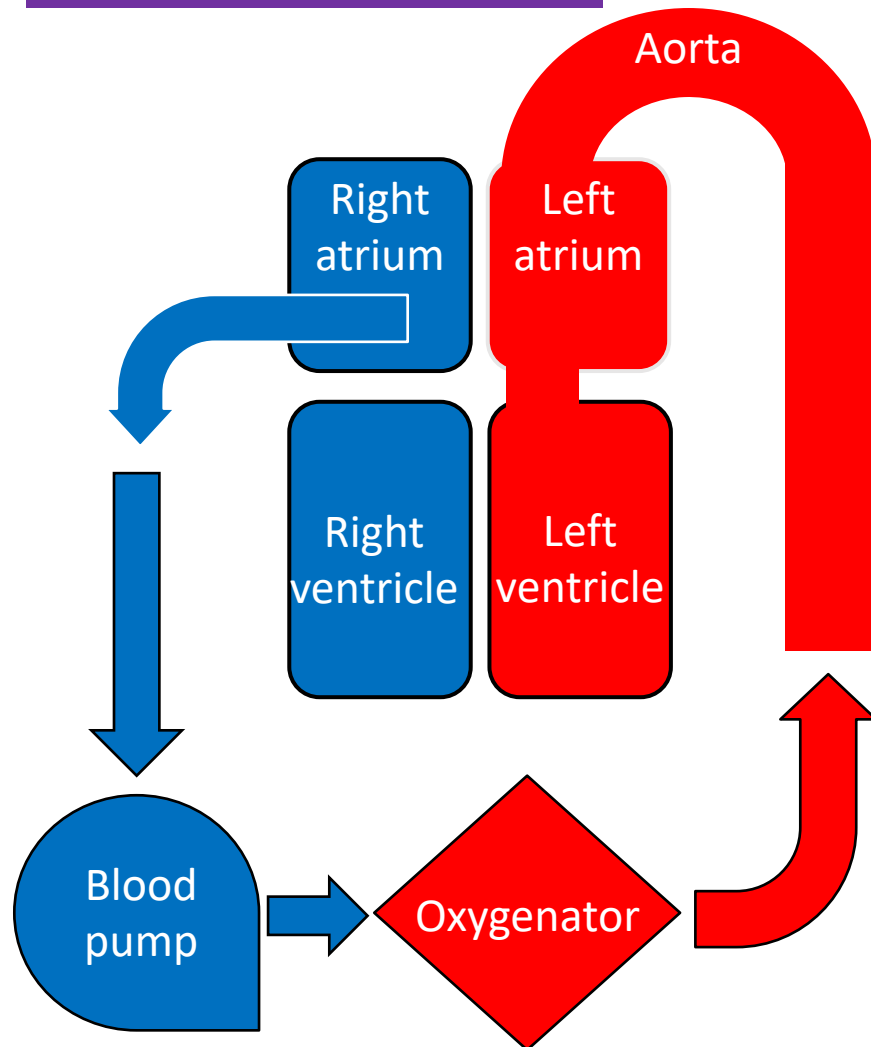
Impella LP 2.5, 3.5 CP, 5.0



Augmentation of CO: 2,5–5,0L/min

Extracorporeal membranous oxygenation - ECMO

V-A konfiguration



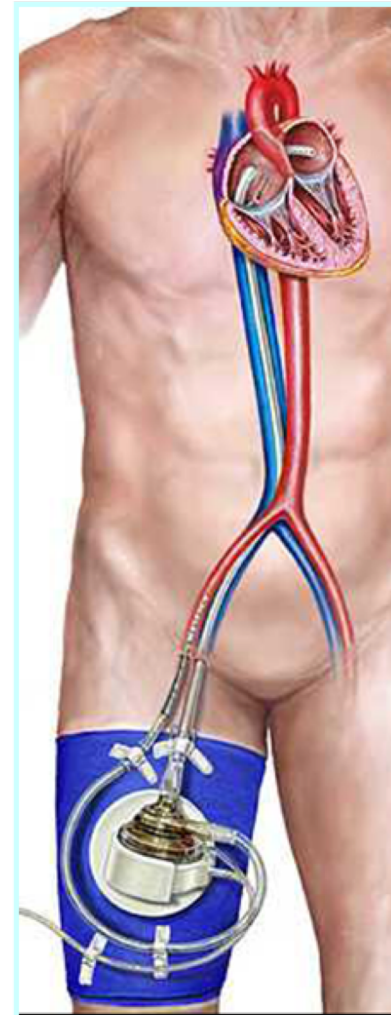
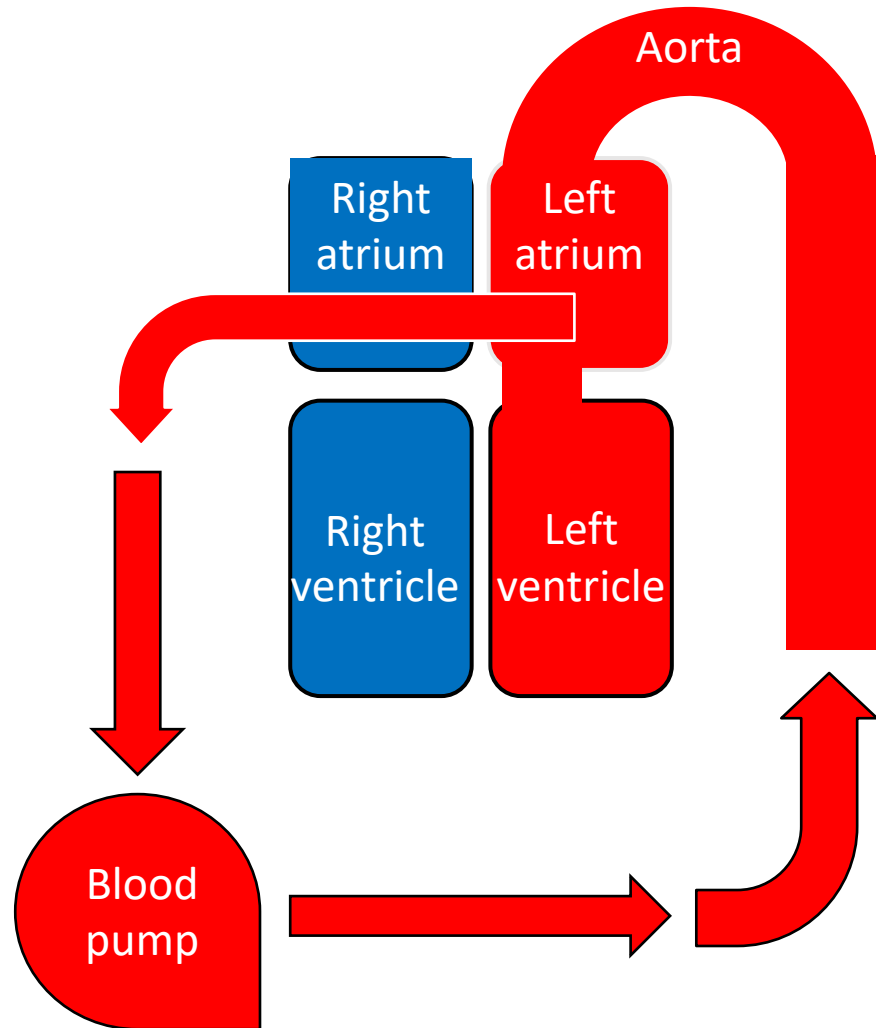
Inflow cannula 20-23Fr

Outflow cannula 15-19F

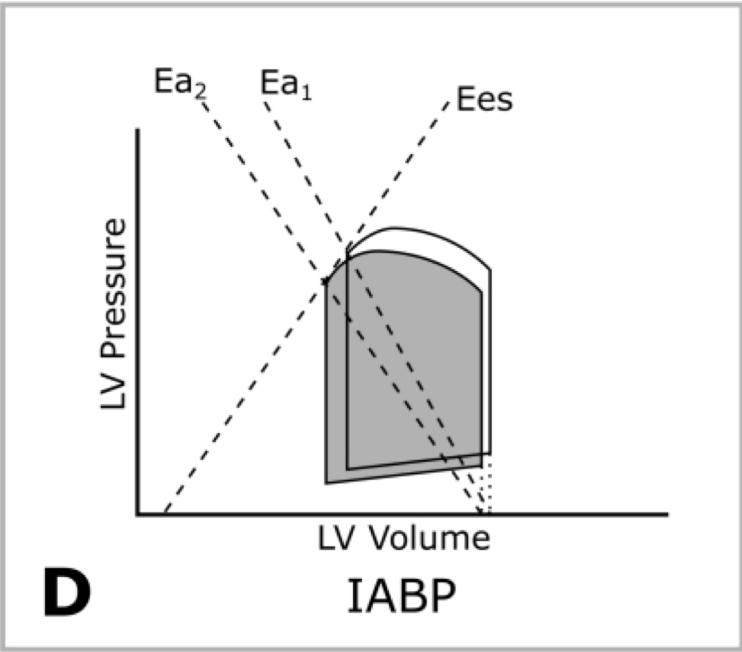
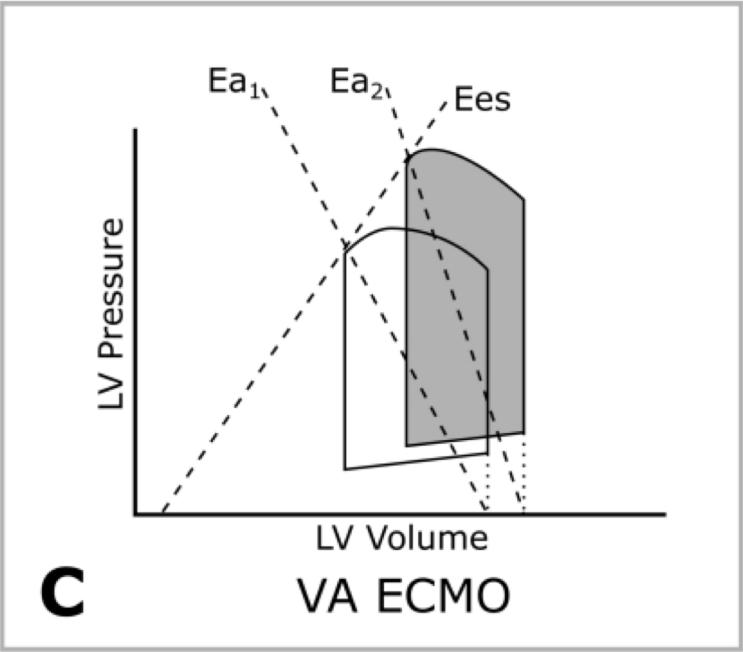
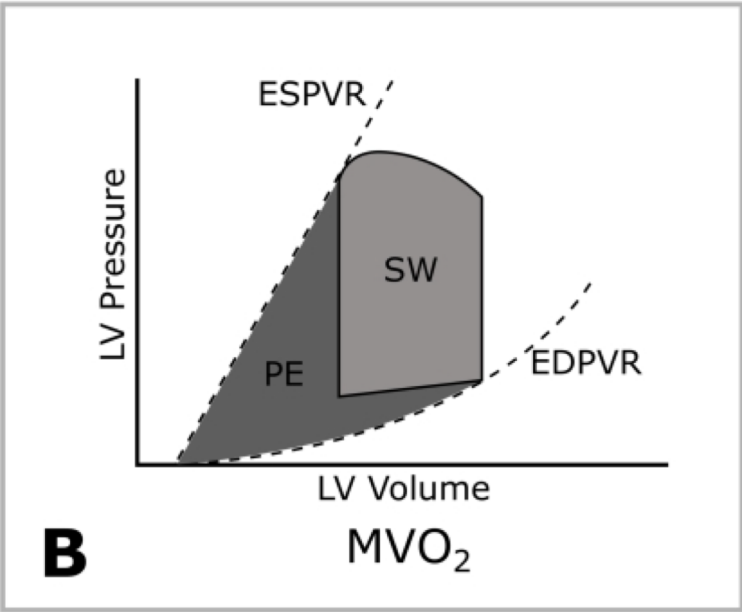
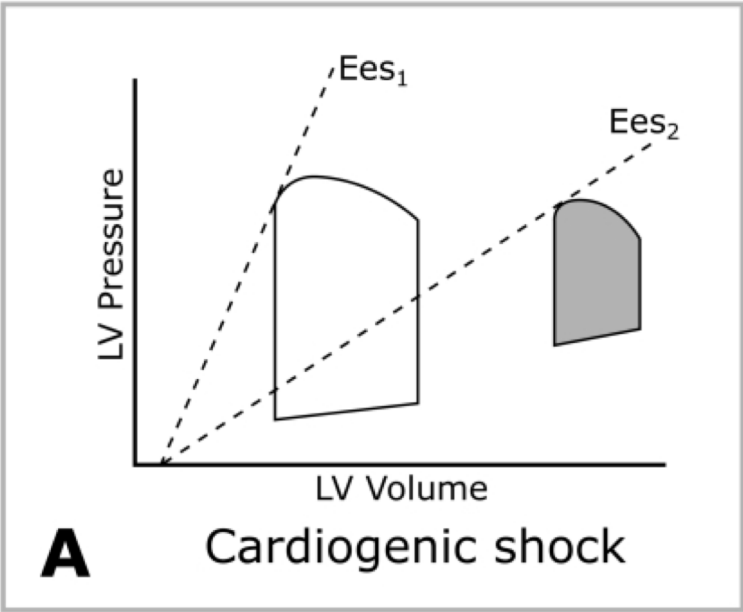
**The heart and the lung
functional replacement**

Augmentation of CO: 4,5–7,0L/min

TandemHeart



Augmentation of CO: 3,5–5,0L/min





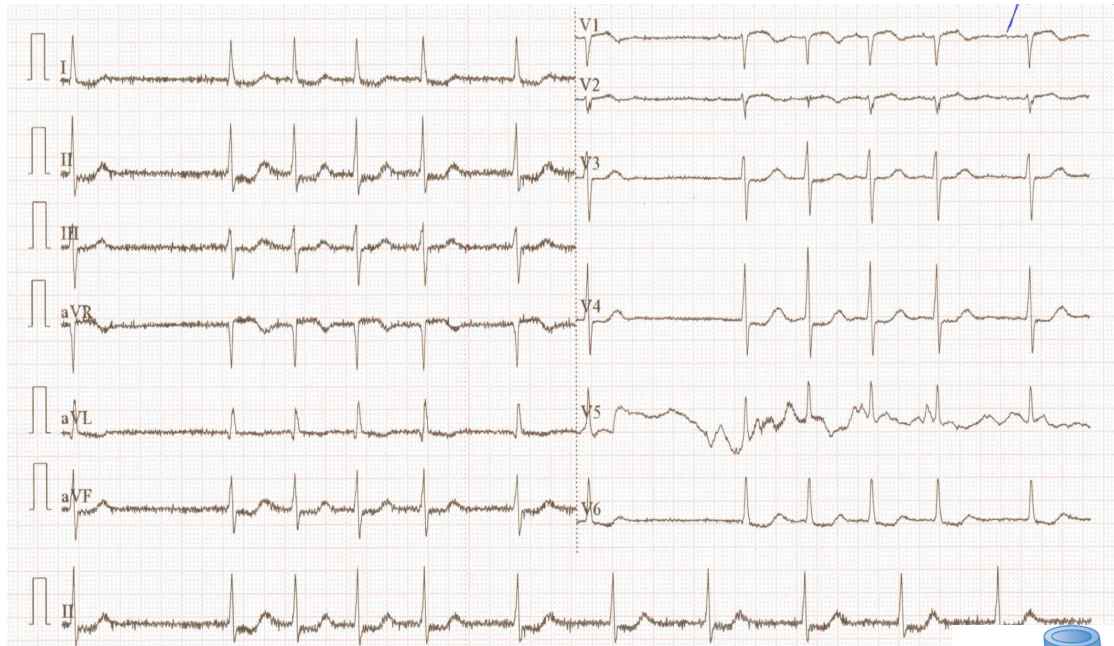
Acute heart failure – summary



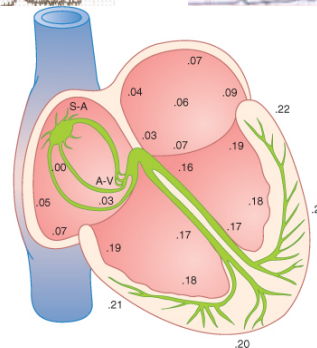
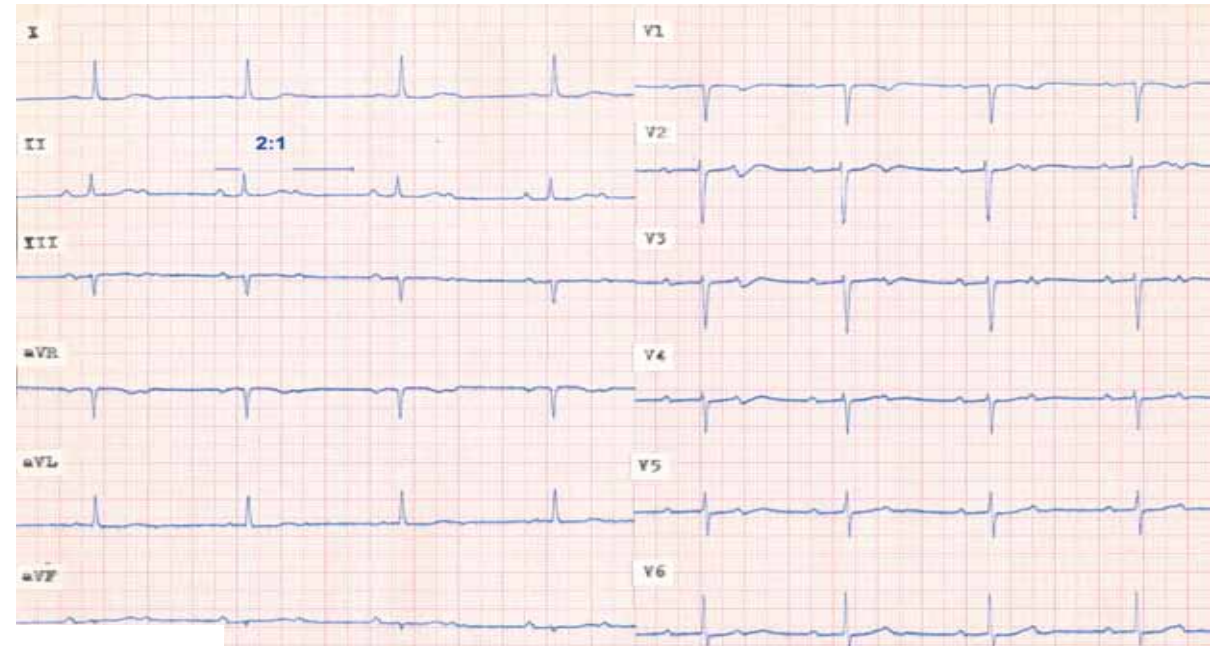
- Primary heart involvement. The myocardium is unable to maintain of the organs needs for blood perfusion
- ALWAYS focus on the underlying cause!!!!
- Pharmacotherapy + mechanical treatment
- Difference with chronic heart failure

Conductive system disorders – cardiac pacing

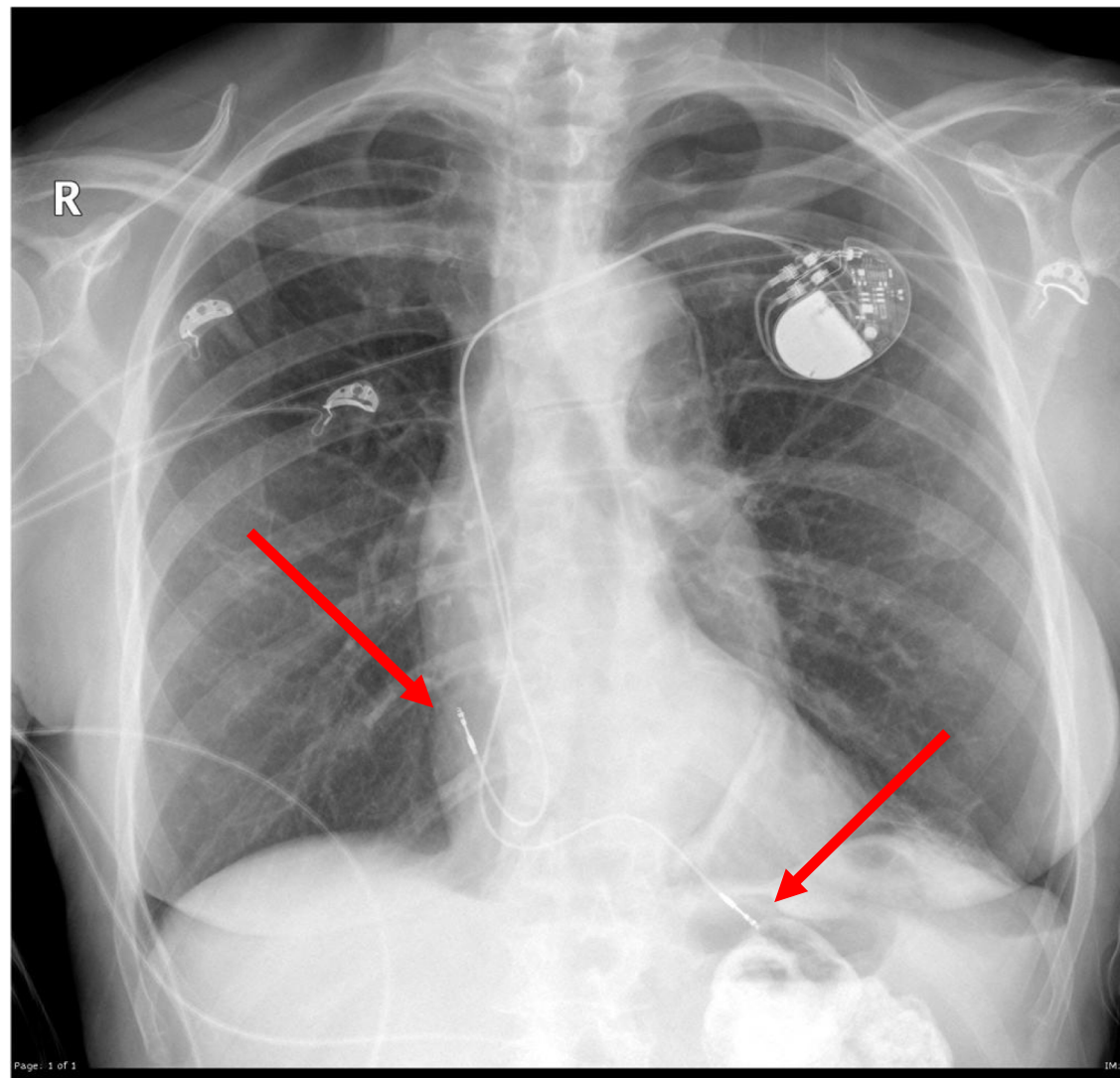
SA block



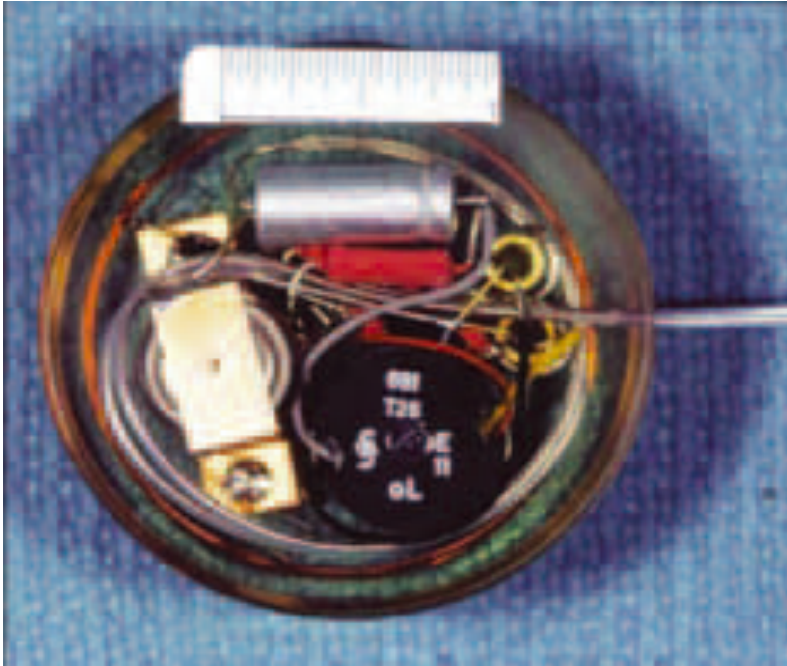
AV block II. degree Mobitz type (Mobitz II)



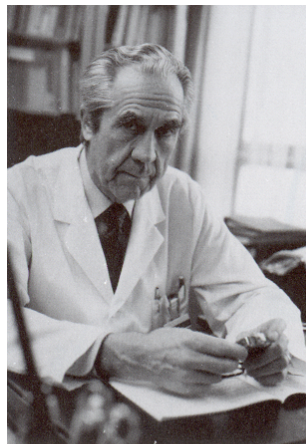
Cardiac pacing



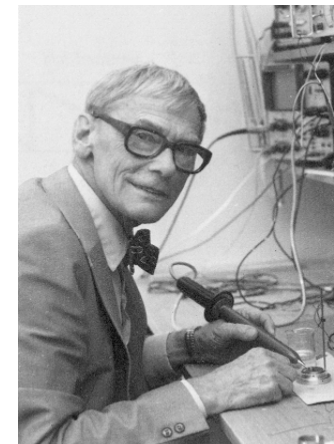
The first cardiac pacing in human patient



- October 8th **1958**
- Karolinska University, Stockholm, Sweden
- Epicardial electrode implantation by cardiosurgical approach



Ake Senning,
cardiosurgeon

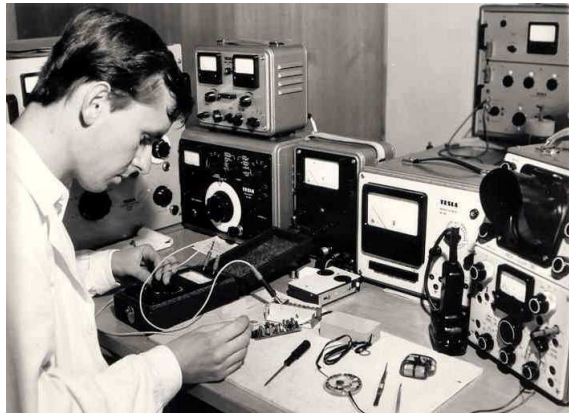


Rune Elmquist,
inventing and engineering

RIMEM V00 Pacemaker, March 1965



Doc. MUDr. Bohumil Peleška, DrSc



Ing. Vladimír Bičík



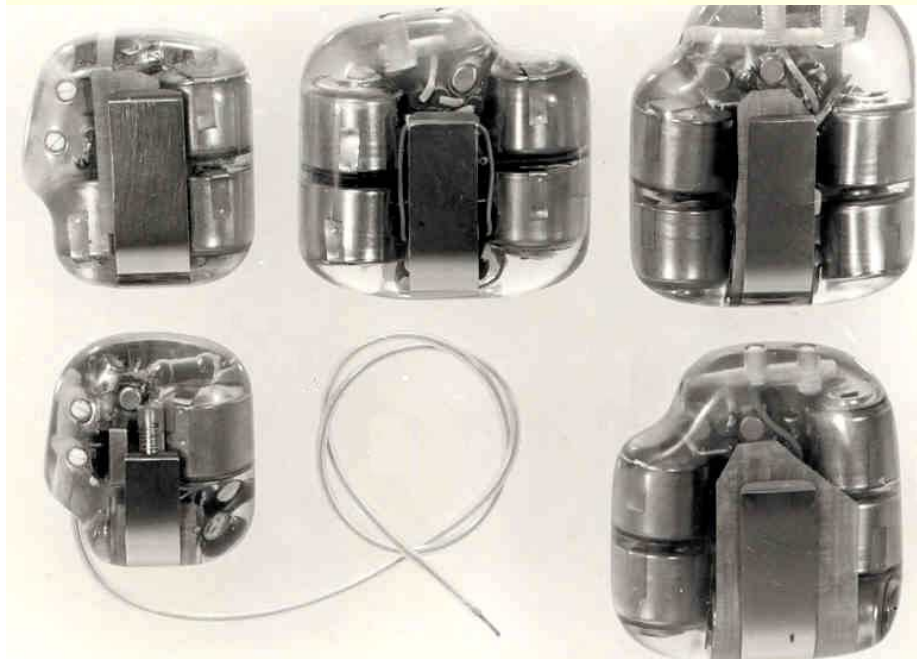
Rimem, Thomayerova Nemocnice, Praha - Krč

PATENTOVÁ LISTINA

ČÍSLO 1 2 4 9 0 1

ÚRAD PRO PATENTY A VYNÁLEZY V PRAZE UDĚLIL PODLE § 19 ZÁKONA Č. 34/1957 Sb. PATENT NA VYNÁLEZ
UVEDENÝ V PŘIPOJENÉM PATENTOVÉM SPISU

PŮVODCE VYNÁLEZU: Doc.MUDr.Bohumil Peleška, Praha
ing.Vladimír Bičík, Nové Strašecí



1967

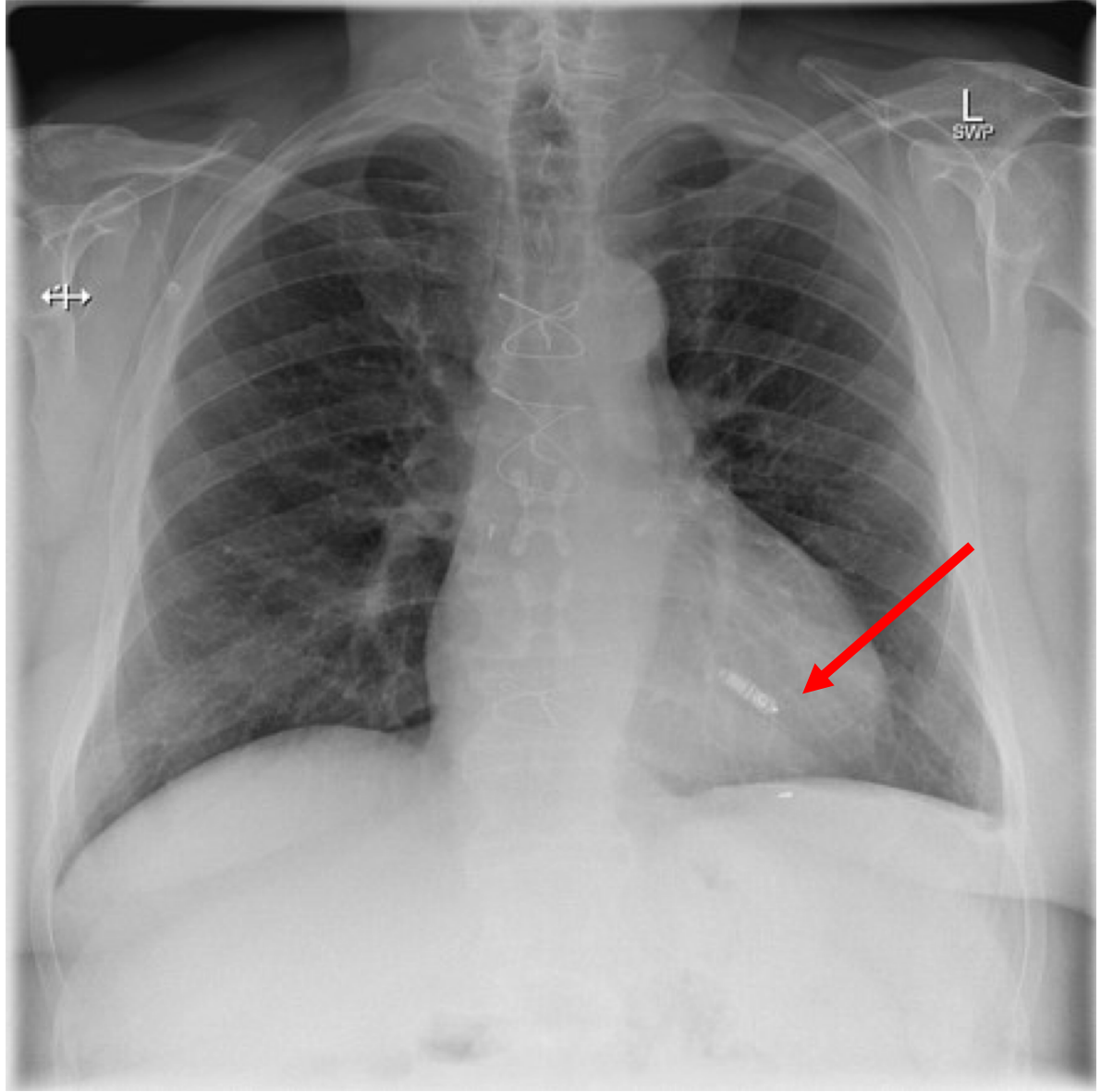
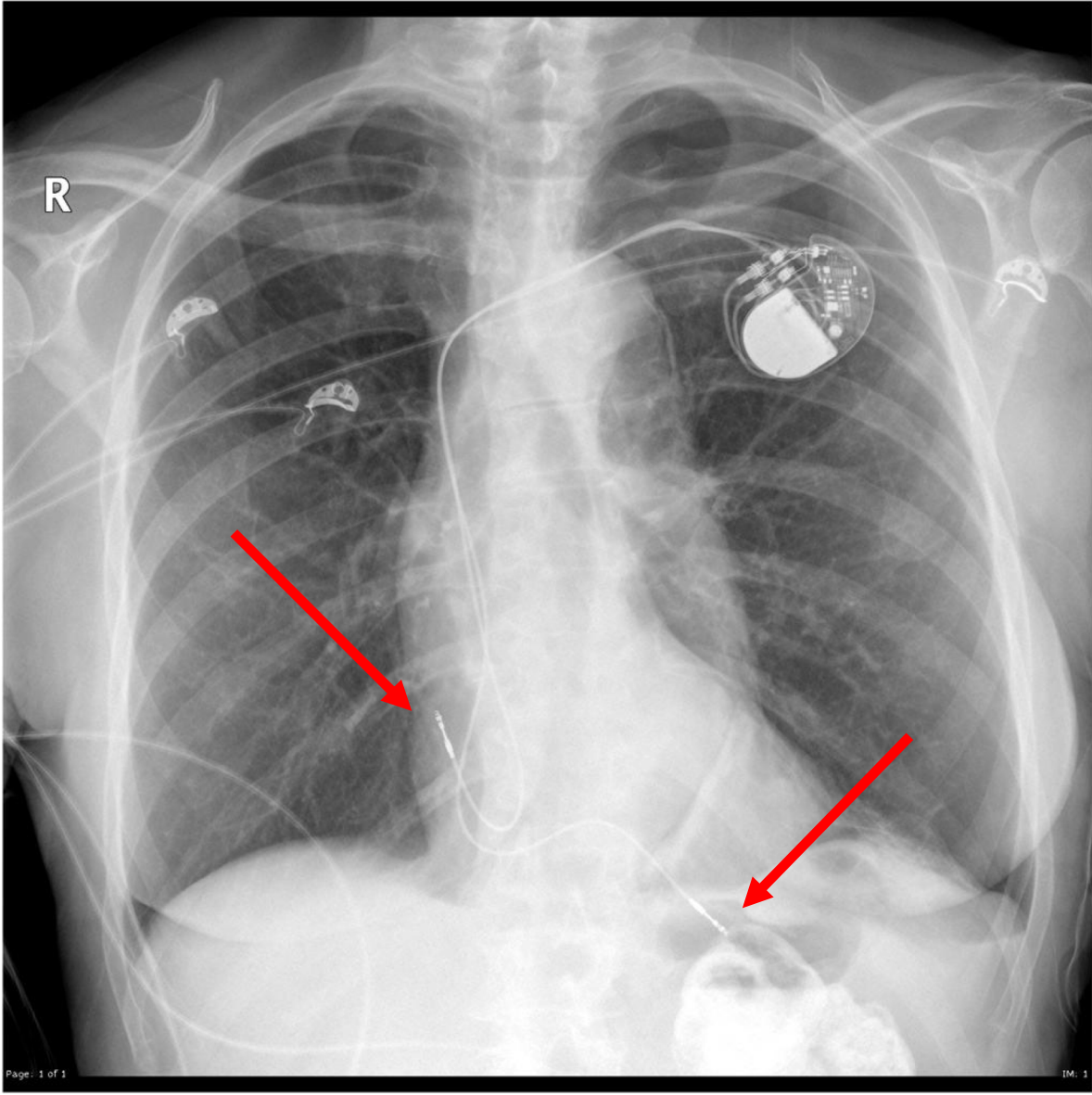


1970 vs. 2000



Leadless cardiac pacing – Micra™







Vasovagal syncope

Short-term regulation of blood pressure - autonomic nervous regulation

Sympathetic / Parasympathetic

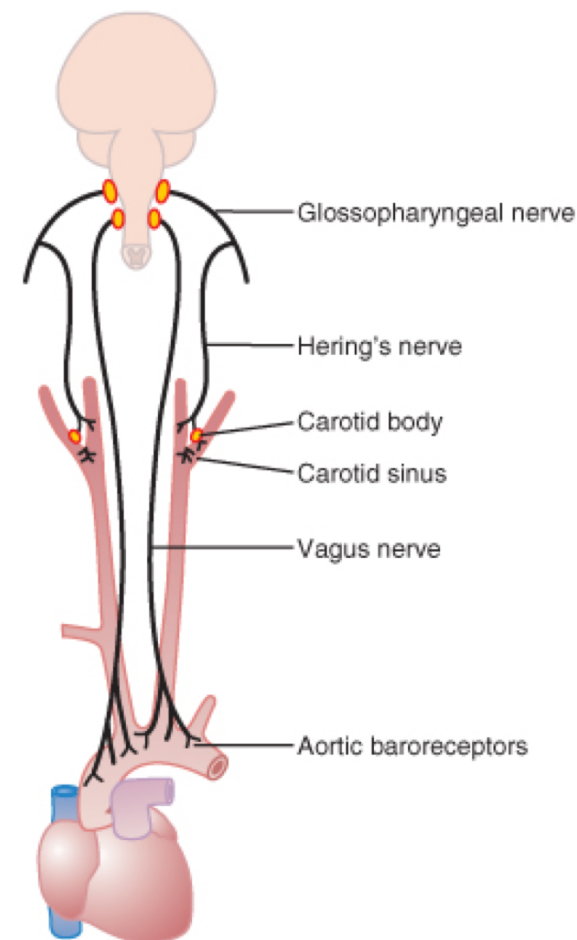
Neural arch

Syncope = short-term loss of consciousness

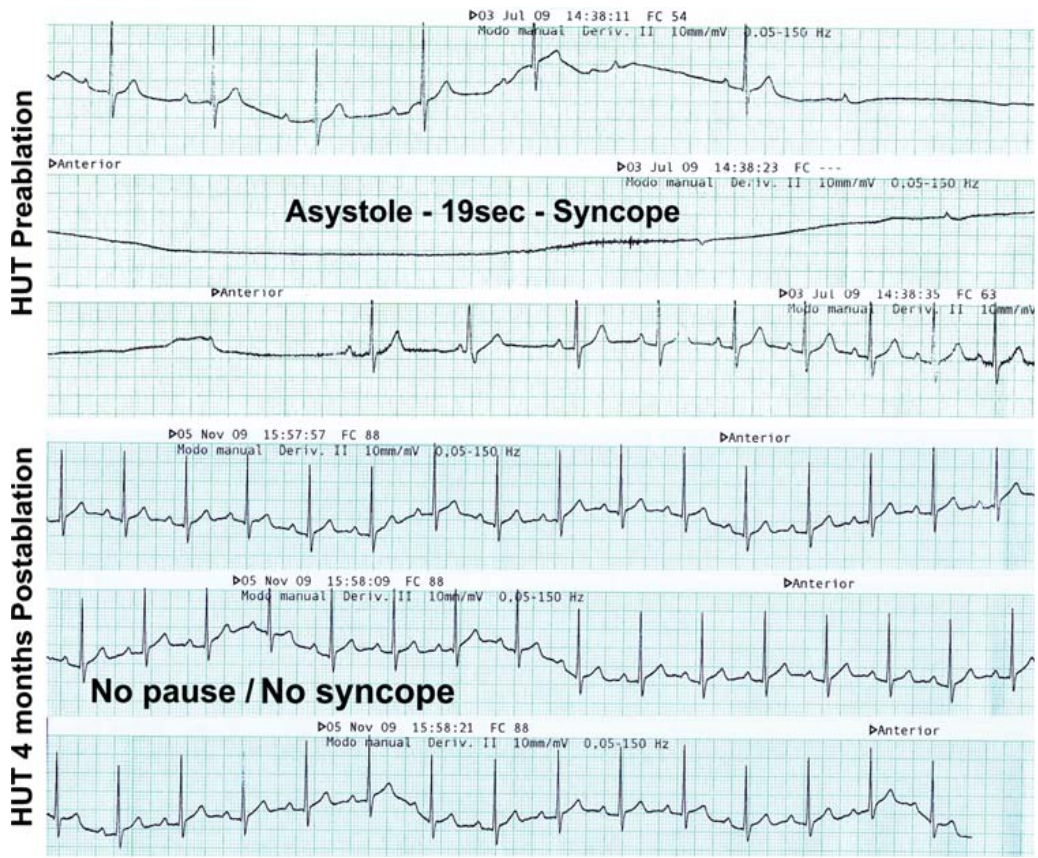
Vasovagal = inadequate activation/inhibition between sympathetic / parasymp.

Regardless of age, rather younger patients

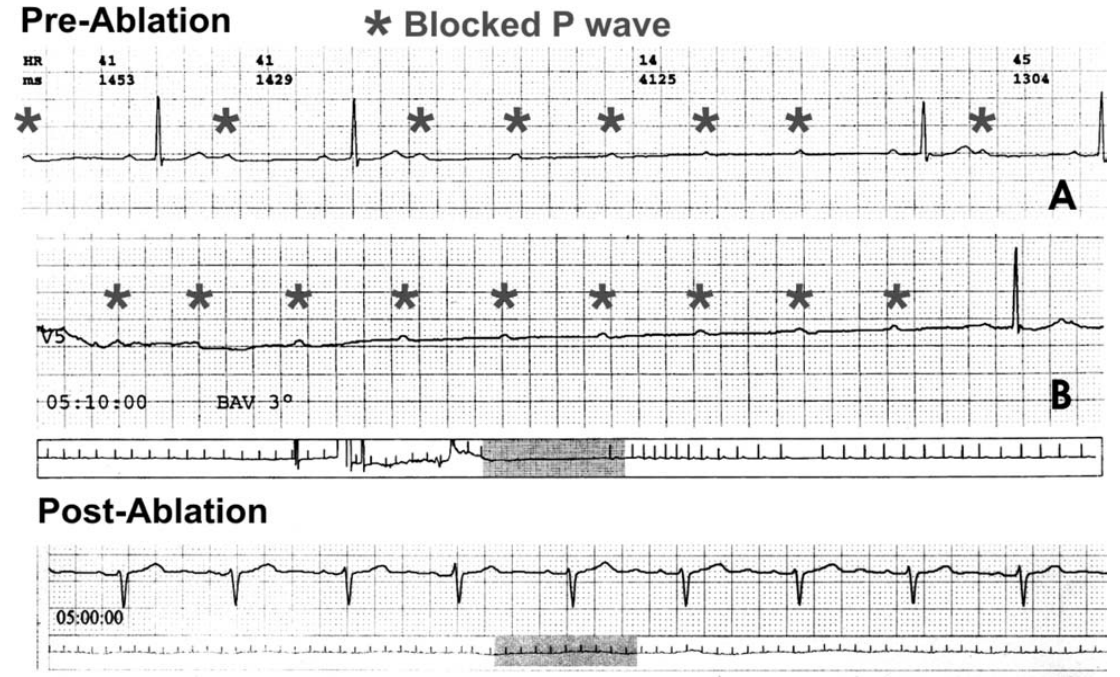
Very unpleasant symptoms, injuries,



- Rapid sharp drop in BP when changing body position....
- Rapid, sudden changes in heart rate

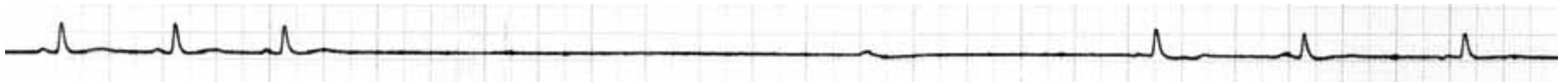


Pachon et al, Europace 2011

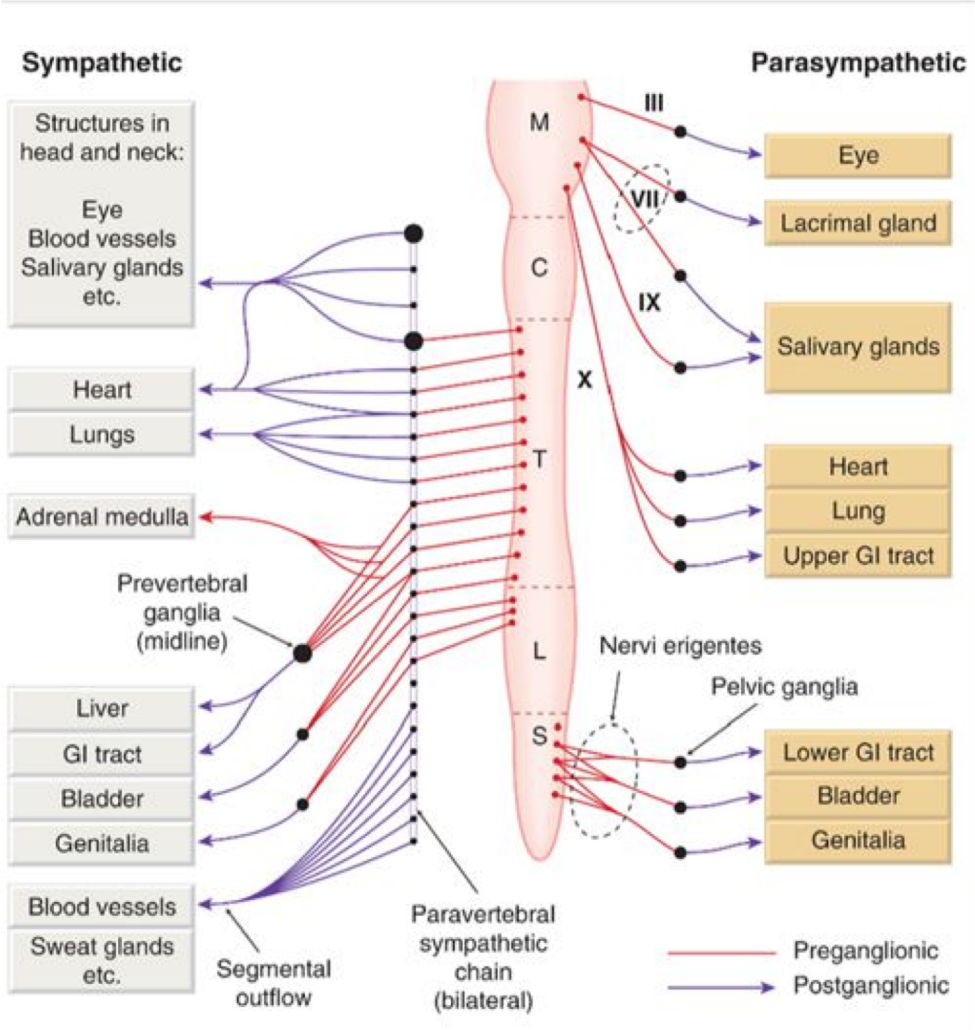


Pachon et al, Europace 2005

Masáž karotického sinu



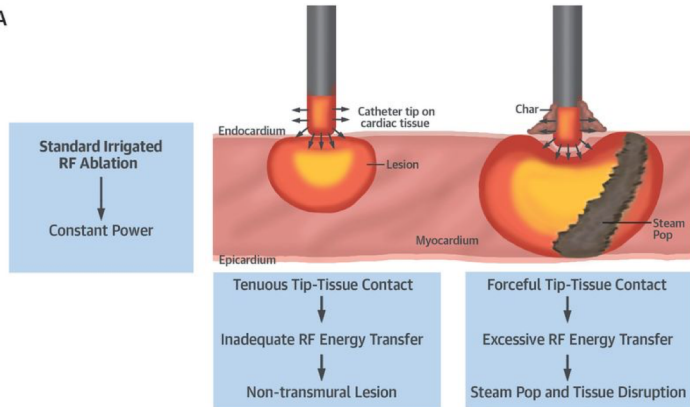
Sympathetic / Parasympathetic system – anatomy



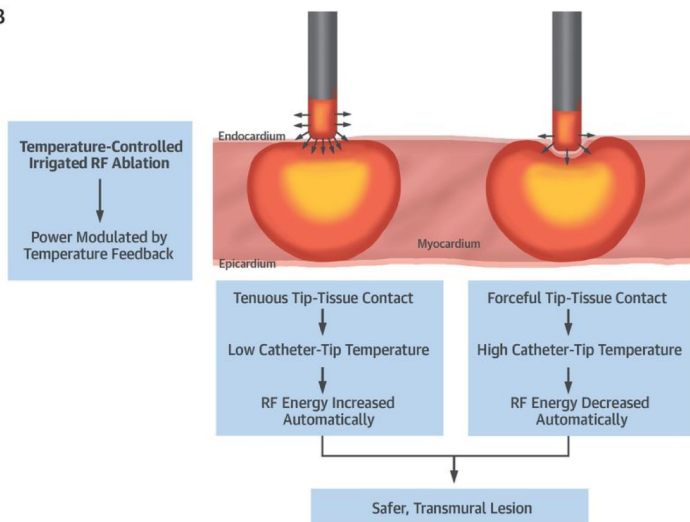
Radiofrequency ablation - principle

CENTRAL ILLUSTRATION: Catheter Tip–Tissue Interactions

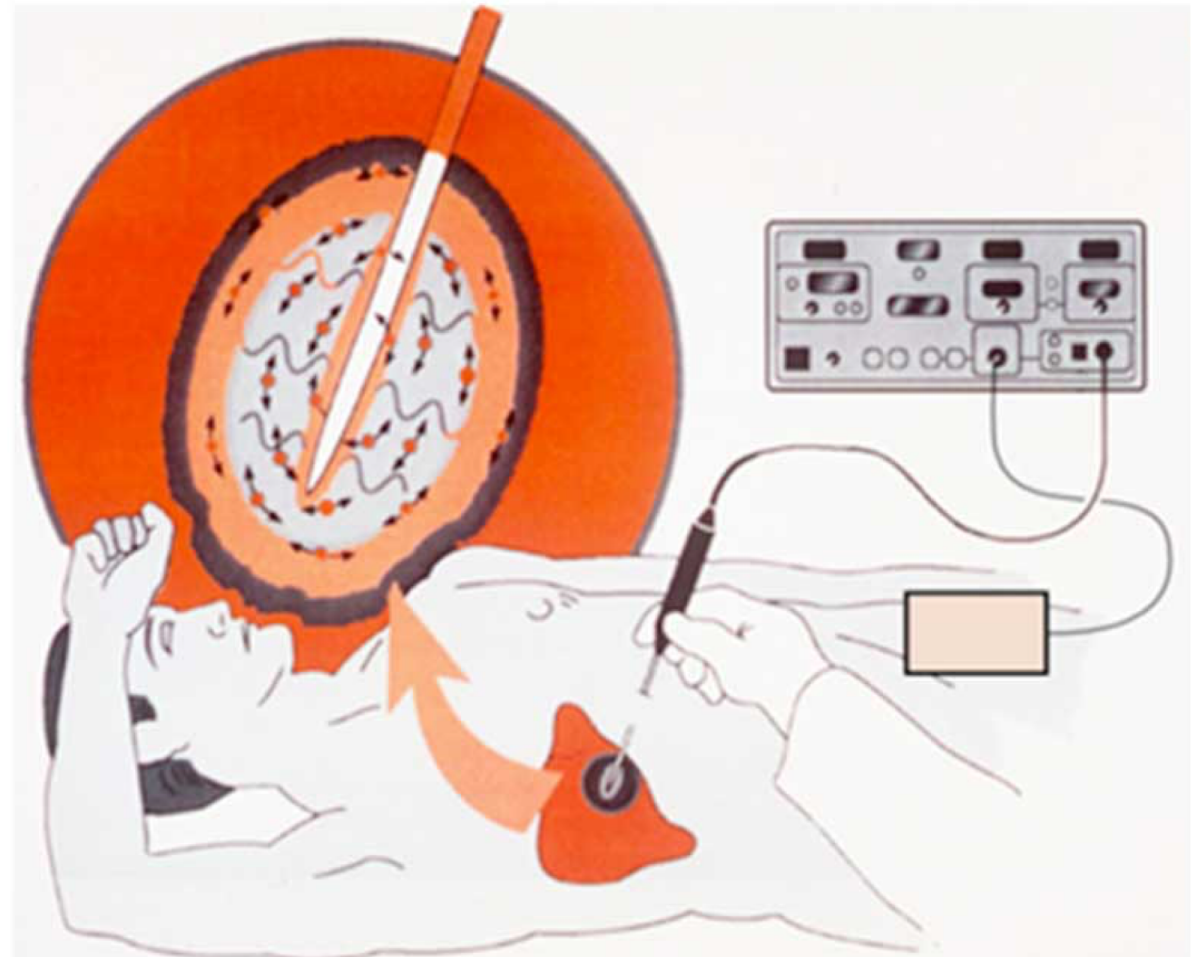
A



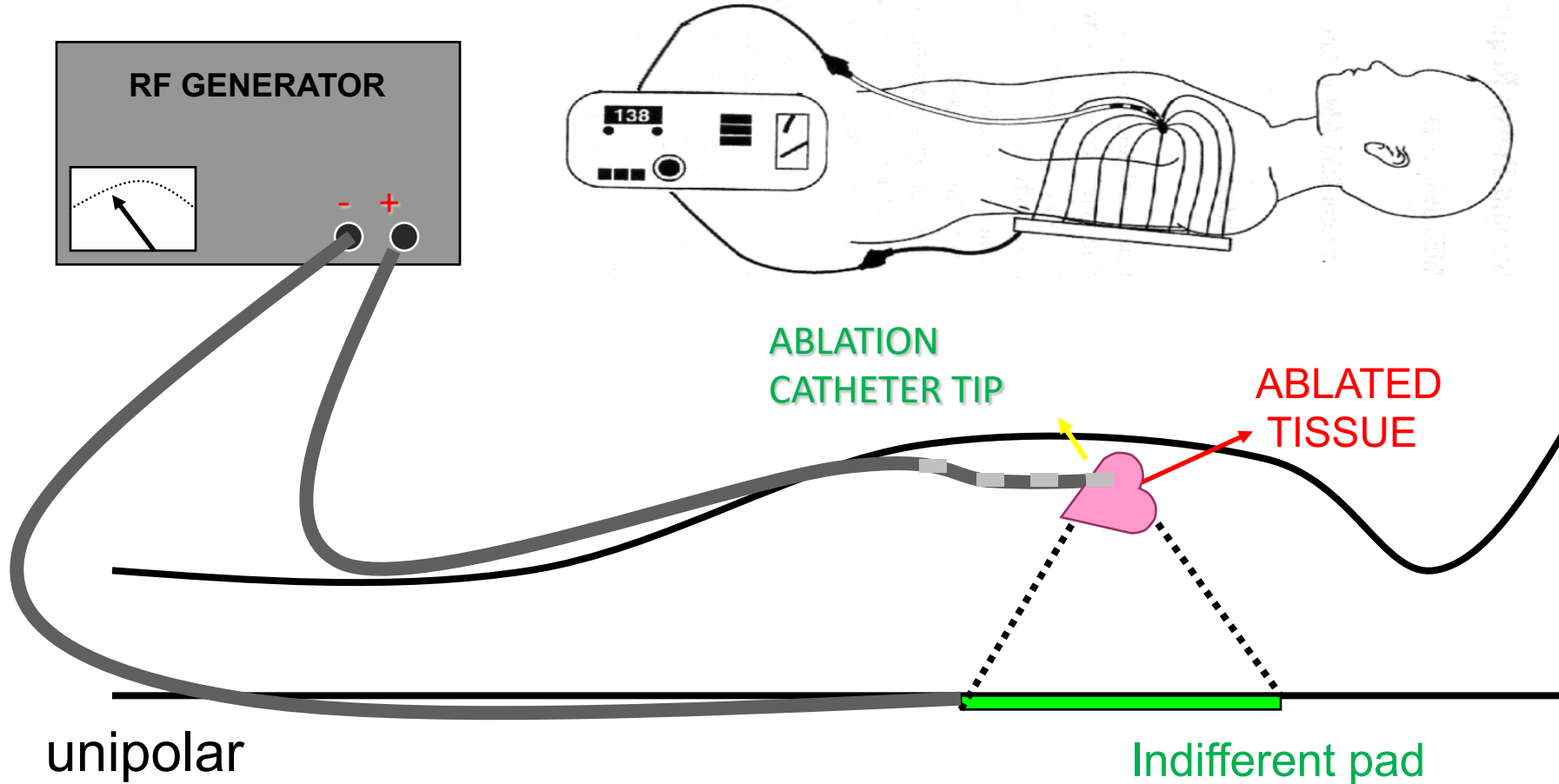
B



RF Ablation: Technique

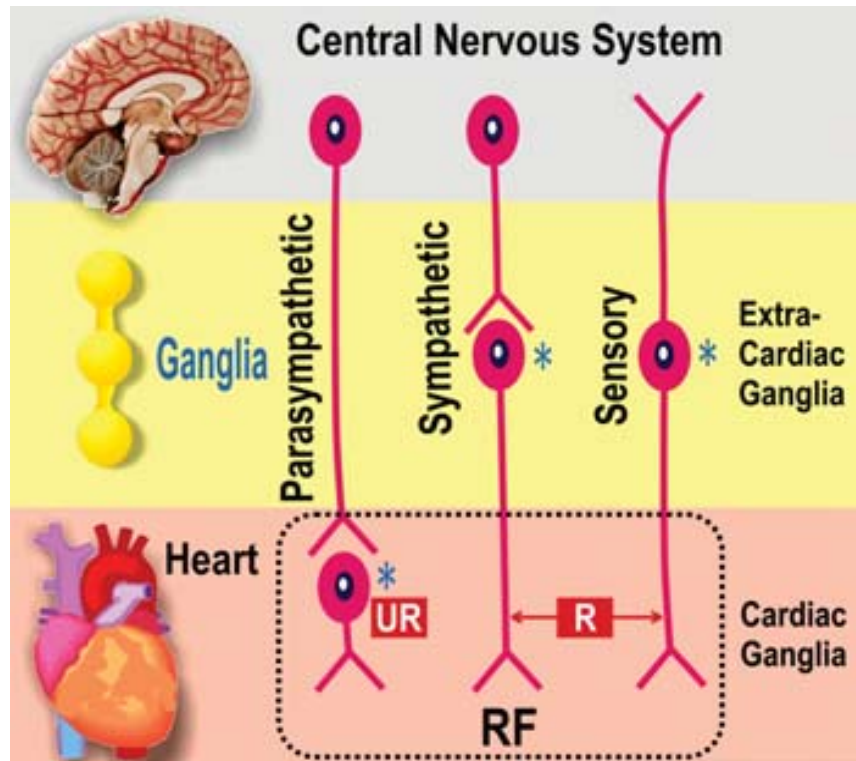


The Electrical Circuit of RF Ablation

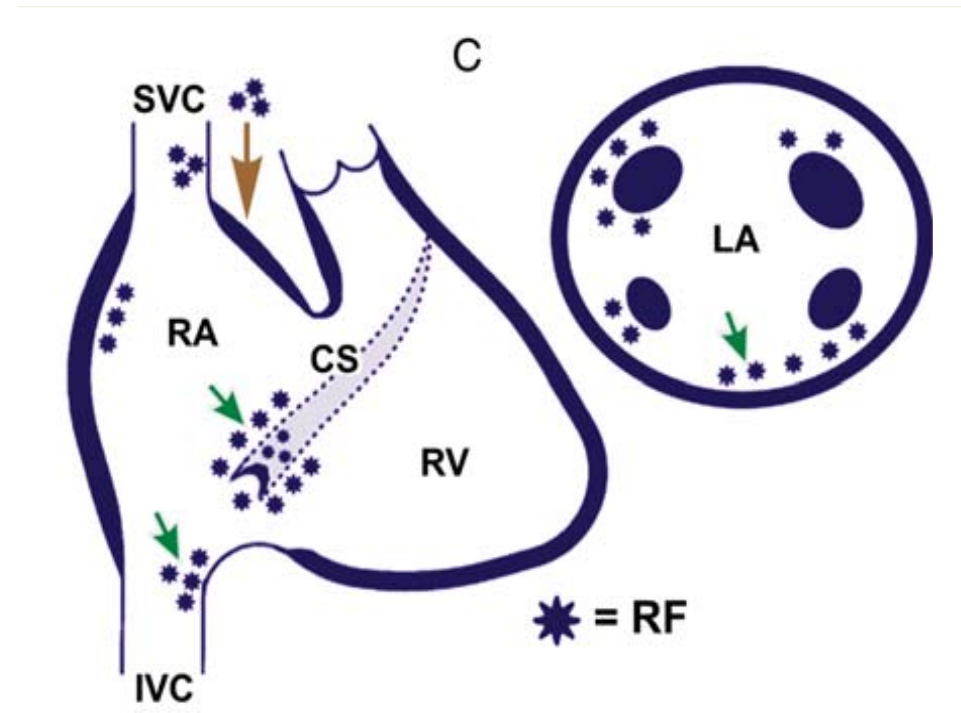


The RF is concentrated at the ablation surface (catheter tip-tissue contact) and disperses throughout the body to a large surface electrode (indifferent electrode)

Vazovagal synkope – treatment principle, RF ablation



Pachon et al, Europace 2011

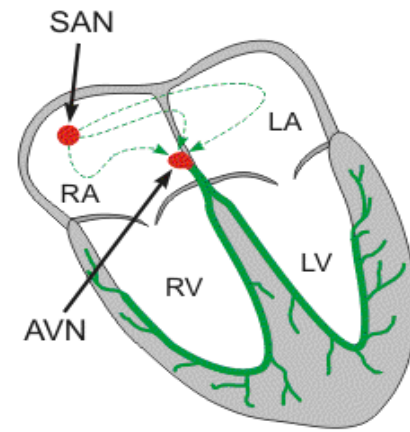
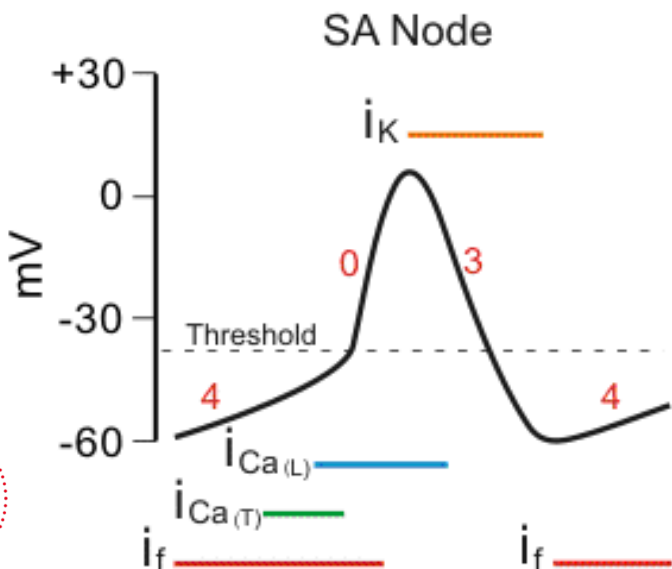


Pachon et al, Europace 2011

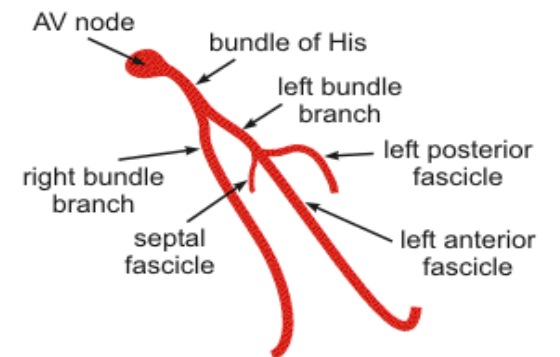


Cardiac arrhythmias – reentry mechanism

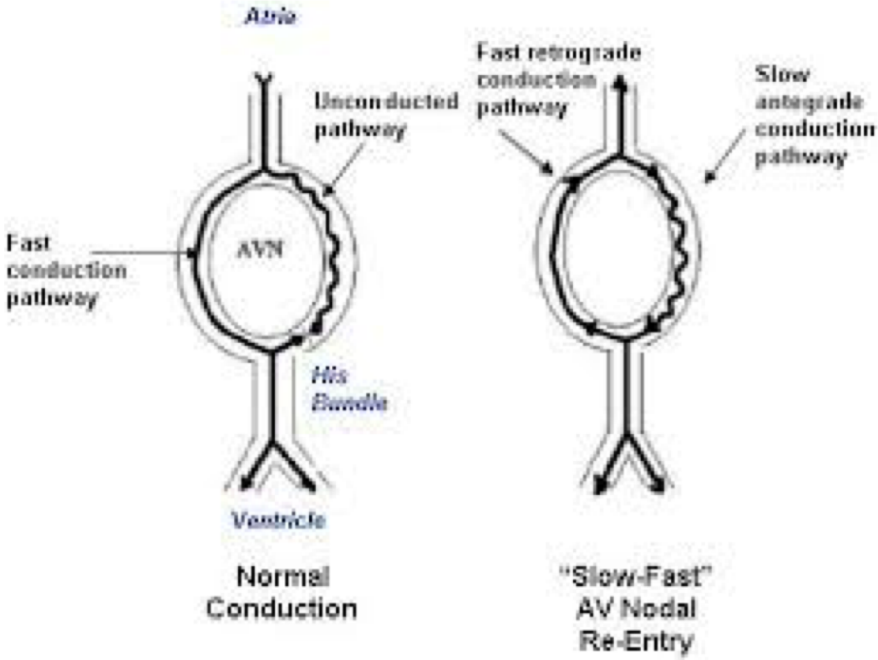
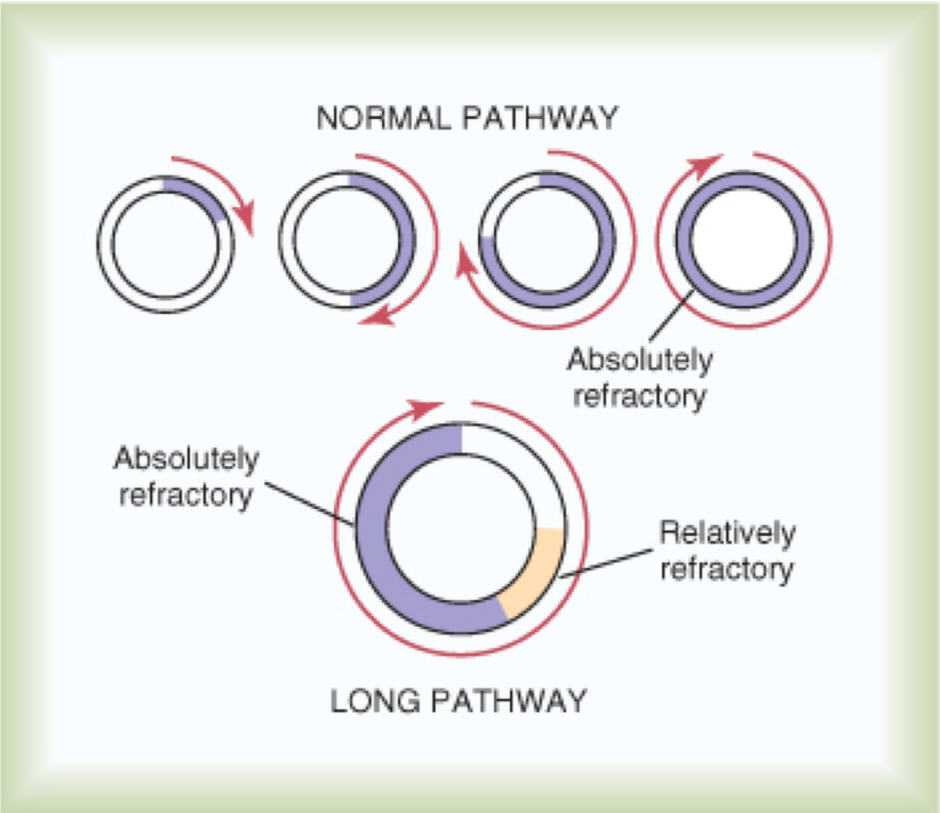
- The most common cause of cardiac arrhythmias
- Pathology of the conduction system – the presence of at least one non-physiological pathway (AV node, atria, ventricles...) or pathological anatomy is required



SAN, sinoatrial node; AVN, atrio-ventricular node; RA, right atrium; LA, left atrium, RV, right ventricle; LV, left ventricle.

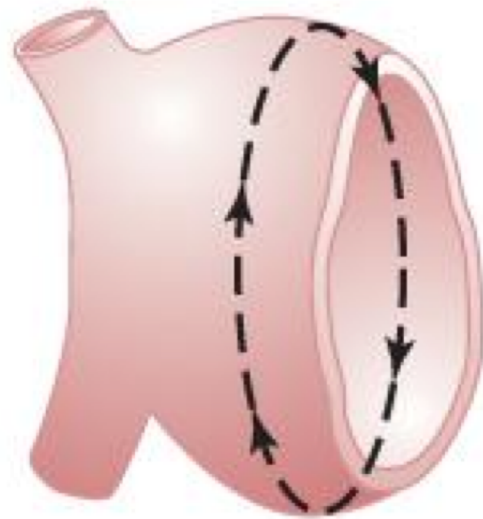


Cardiac arrhythmias – reentry mechanism



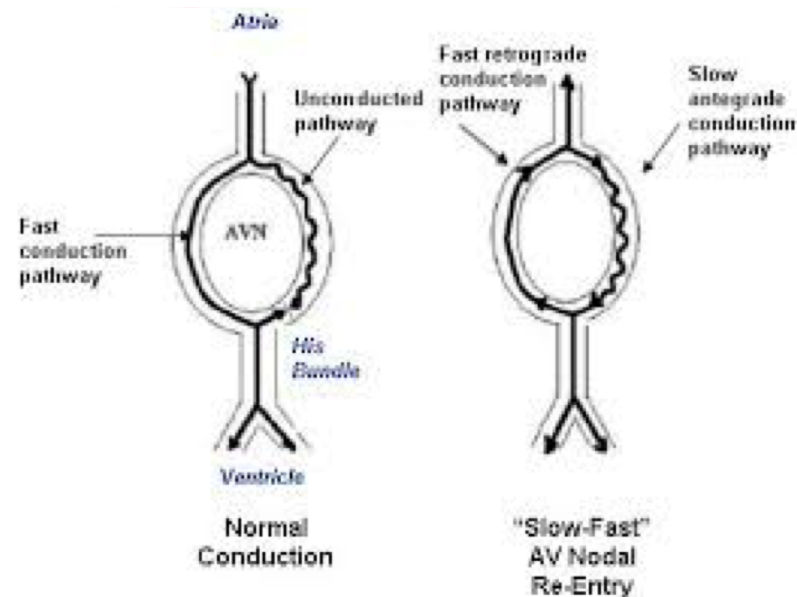
Cardiac arrhythmias – reentry mechanism

Atrial flutter

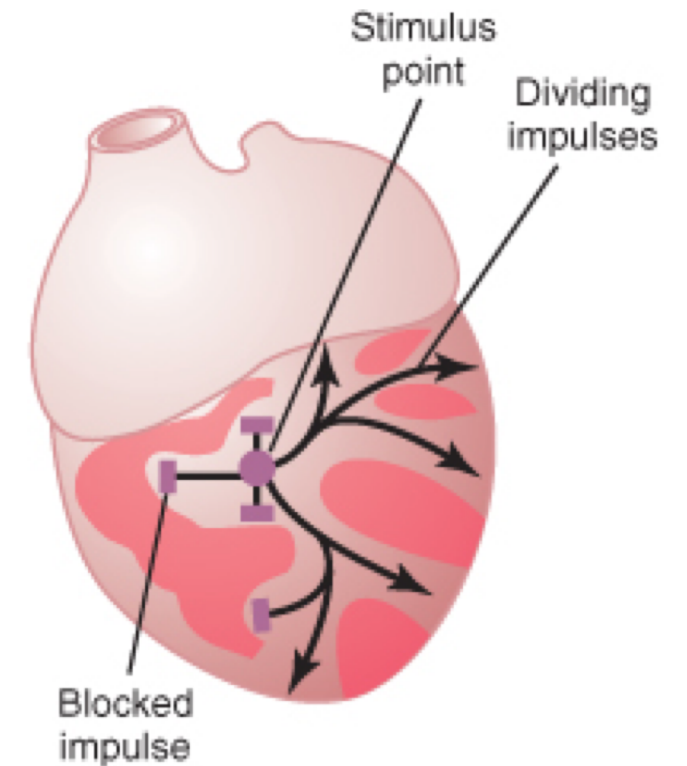


Atrial flutter

AVNRT

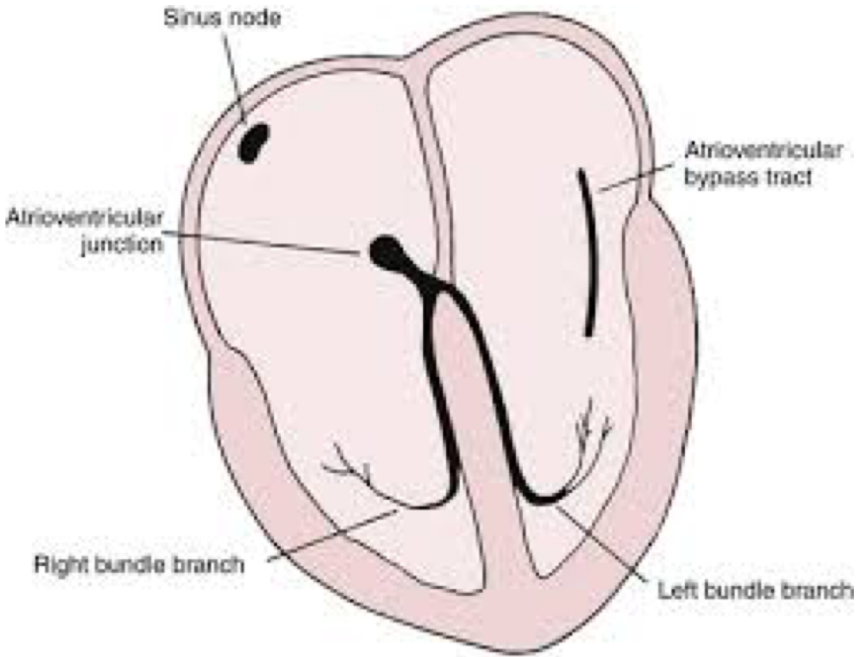
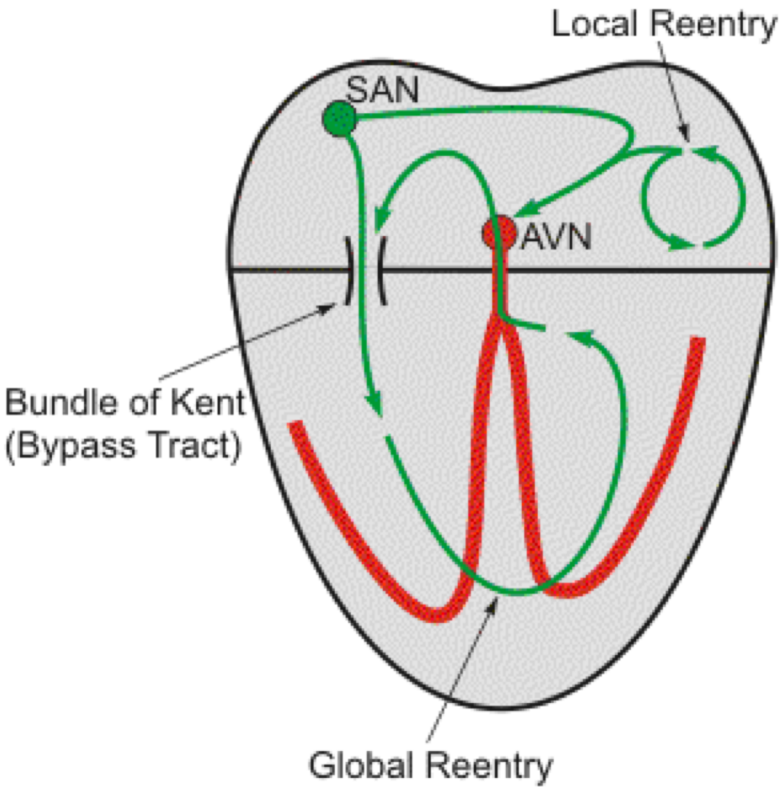


Ventricular tachycardia – ischemic substrate based



Cardiac arrhythmias – reentry mechanism

AVRT



Reentry mechanism – treatment

- pharmacotherapy – very limited effectiveness
- RF ablation – **interruption of the reentry circuit!!!!**

