



Petr Fila

CARDIAC SURGERY

- general principles
- congenital heart disease
- ischemic heart disease

Cardiac surgery history

- 1896 - heart stab wound suture (Rehn)
- 1923 - „close path“ mitral stenosis operation (Cutler,Levine)
- 1925 - comisurolysis of mitral valve through LA appendage (Soultar)
- 1938 - open arterial duct ligation (Gross)
- 1944 - Blalock-Taussig shunt in tetralogy of Fallot
- 1944 - surgery for coarctation of the aorta – resection (Crafoord)
- 1953 - atrial septal defect closure – hypothermia (Lewis)
- 1953 - EXTRACORPOREAL CIRCULATION – ASD closure (Gibbon)
- 1955 - surgery for tetralogy of Fallot (Kirklin)
- 1960 - aortic valve replacement (Harken)
- 1960 - mitral valve replacement (Starr)
- 1962 - heart revascularization with vein grafts
- 1964 - heart revascularization with LITA
- 1967 - heart transplantation
- 1967 - artificial heart (Cooley)



Cardiac surgery in hypothermia

First open heart surgery in hypothermia –
ASD closure (Navrátil, Brno 1956)



Surgical approaches in cardiac surgery

Median sternotomy

Ministernotomy (aortic valve, asc. aorta, ...)

Thoracotomy

- right side (ASD, Mi, Tri, re-do surgery)
- left side (open arterial duct, CoA, decs. aorta)

Minithoracotomy

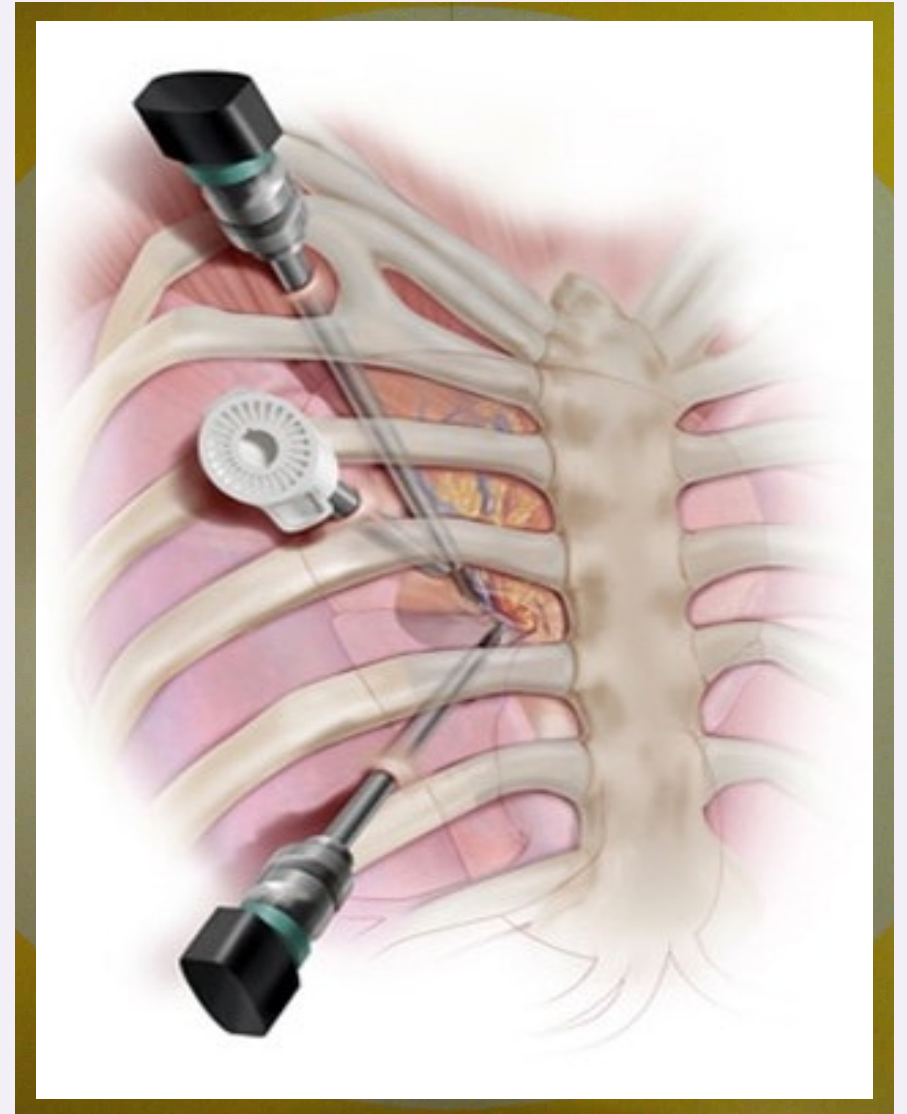
- left side – ischemic heart disease, open arterial duct)
- right side (IHD)

Transverse sternotomy

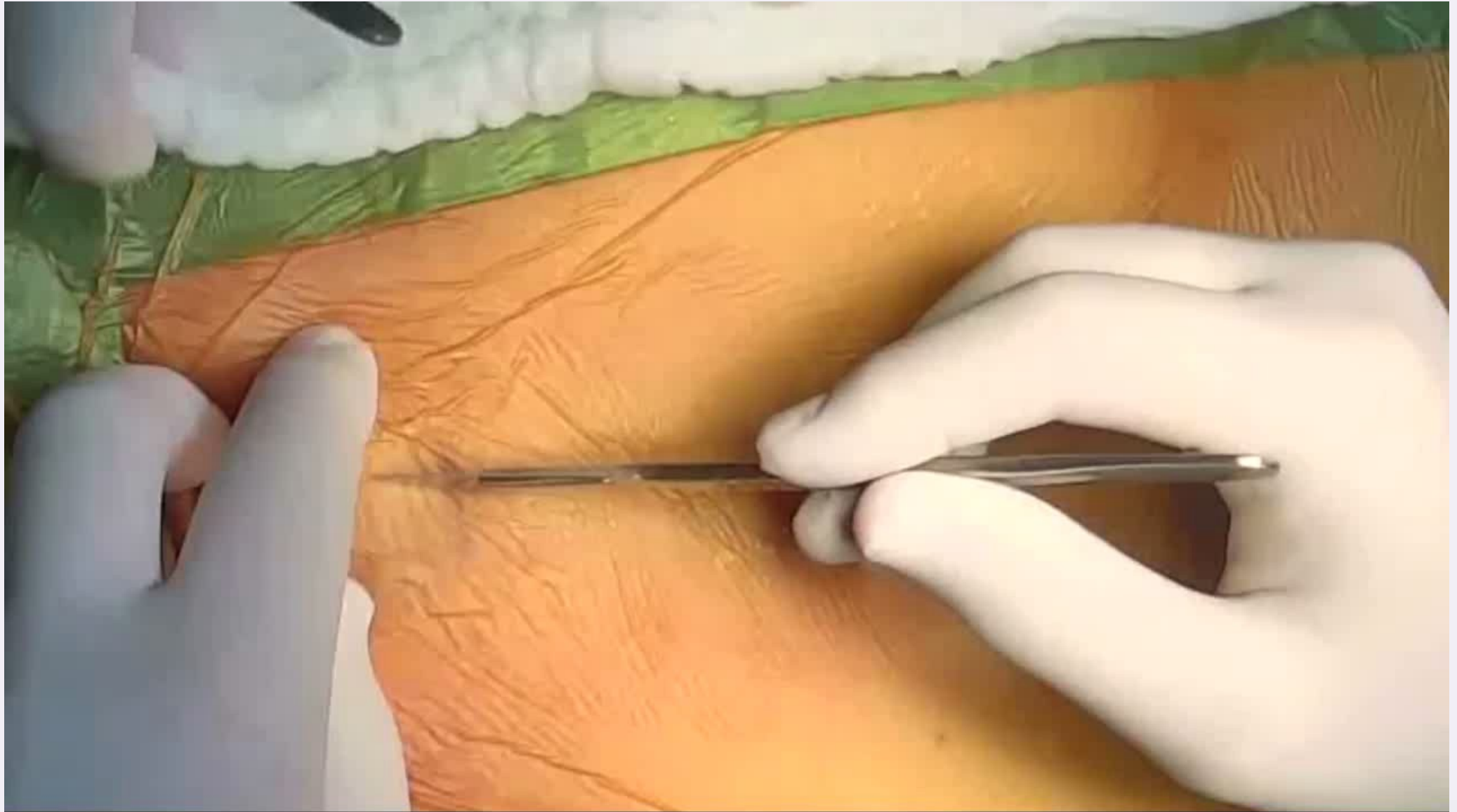
Parasternal incision

Incision in the epigastrium

Endoscopic approach (robotic)



Ministernotomy



Cardiac surgery

- without cardiopulmonary bypass - beating heart surgery

- congenital heart diseases (open arterial duct, CoA)
- CABG
- pericarditis
- heart injury
- mitral commissurotomy (history)

- with cardiopulmonary bypass (ECC)



Extracorporeal circulation – cardiopulmonary bypass

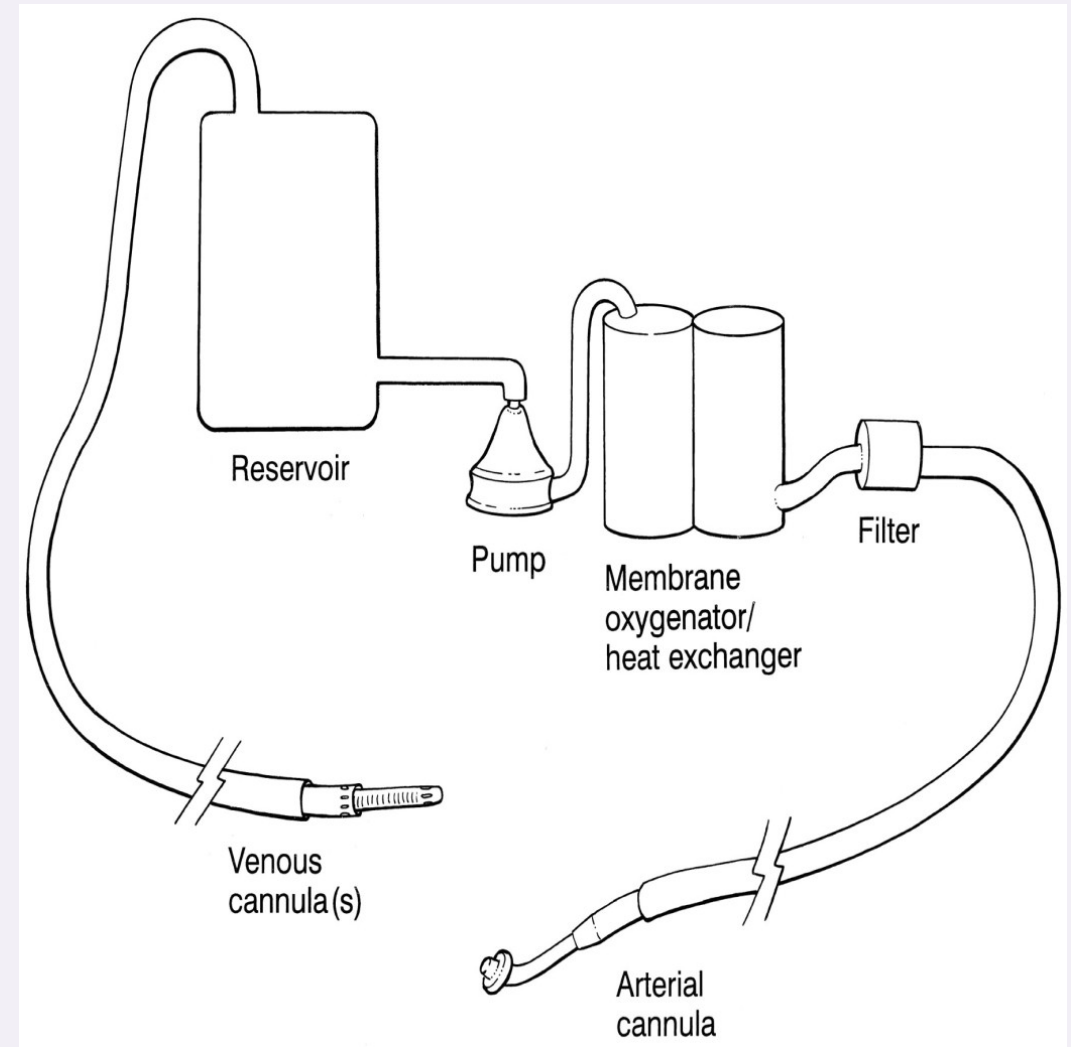
1. Pump

2. Oxygenator

3. Heat exchanger

principles

- heparinization (2-3 mg/kg)
- hemodilution
- hypothermia/normothermia



Extracorporeal circulation



First ECC in central Europe

Brno, 1958



Extracorporeal circulation nowadays



collaboration between cardiac surgeon, anesthesiologist and perfusionist



Myocardial protection

ischemic cardiac arrest = myocyt injury

- complete electromechanical arrest
- cell membrane stabilization
- myocardial cooling – to achieve metabolic suppression

Cardioplegic solution

crystalloid x blood
warm x cold

Types of delivery

antegrade
retrograde



Heart diseases

Congenital

- without shunting
- left to right shunt
- right to left shunt

Acquired

- ischemic heart diseases
- valve diseases
- aortic diseases
- tumors
- others



Congenital heart diseases

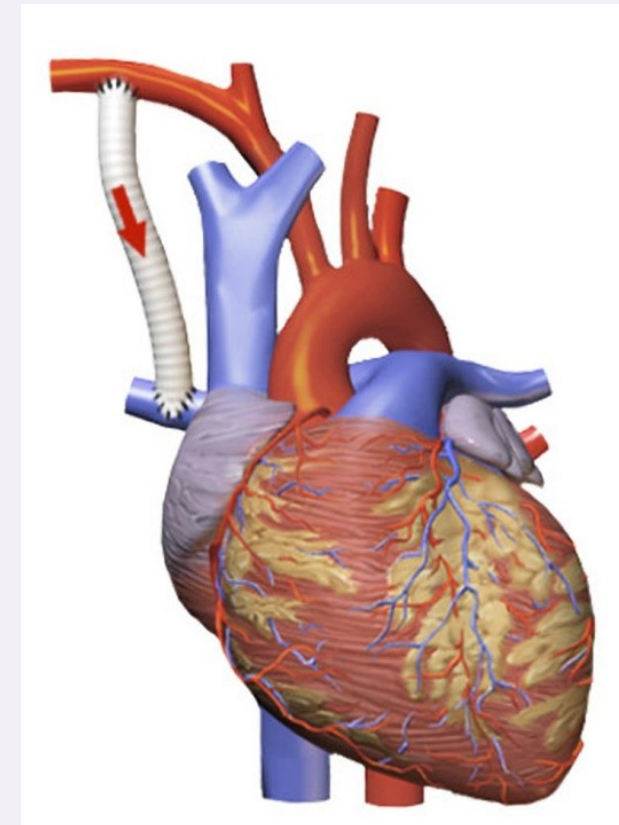
0,6-0,8% newborns

the most often - VSD, ASD, open arterial duct

main principles of treatment

- critical defects - early repair
- others – at the preschool-age surgery

- radical correction
- palliative surgery
 - connection (shunt) between systemic and pulmonary circulation



Advance in congenital heart surgery

- fetal ECHO development, noninvasive diagnosis
- reduction of palliative surgery
- **radical correction during first step of surgery**
- catheter intervention techniques development
(BAS, ASD and VSD closure, PDA closure, coils, stents, dilation)
- post surgery mortality reduction, intensive care



Congenital heart diseases

85% of CHD live to the age of adult

50% - absolutely healthy

25% - time to time observation
(possibility occurrence of residues)

25% - regular observation
if need - reintervention



Congenital heart diseases - types

Congenital

- **without shunt**
- left to right shunt
- right to left shunt

coarctation of aorta
aortic arch disorders
aortic stenosis
pulmonary stenosis

Acquired

- ischemic heart diseases
- valve diseases
- aortic diseases
- tumors
- others



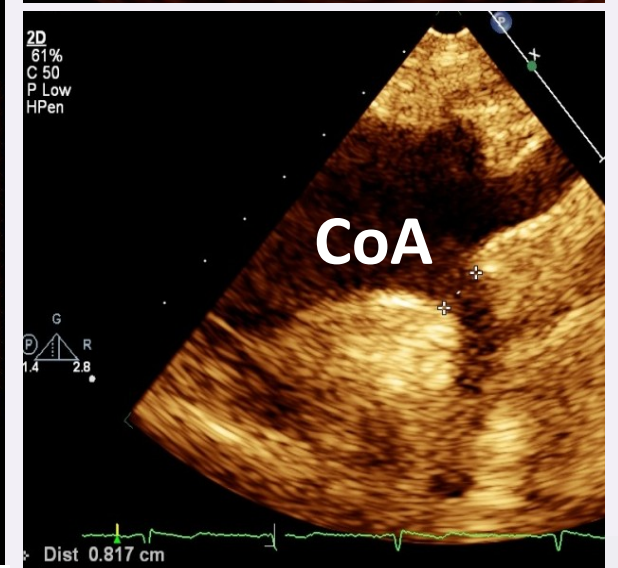
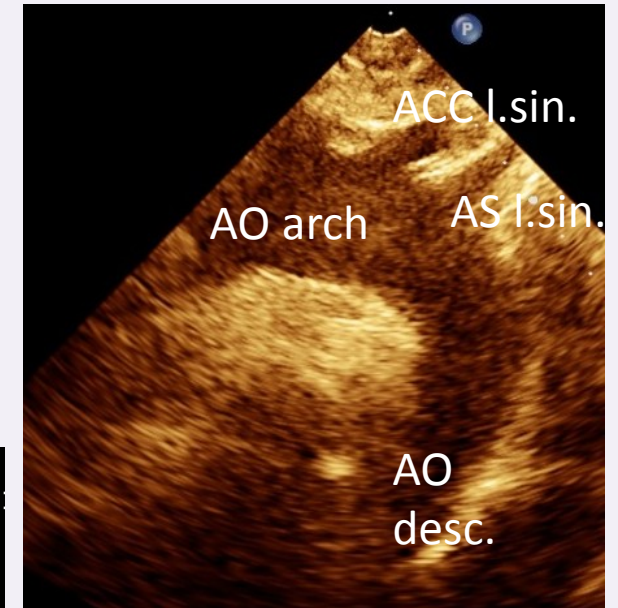
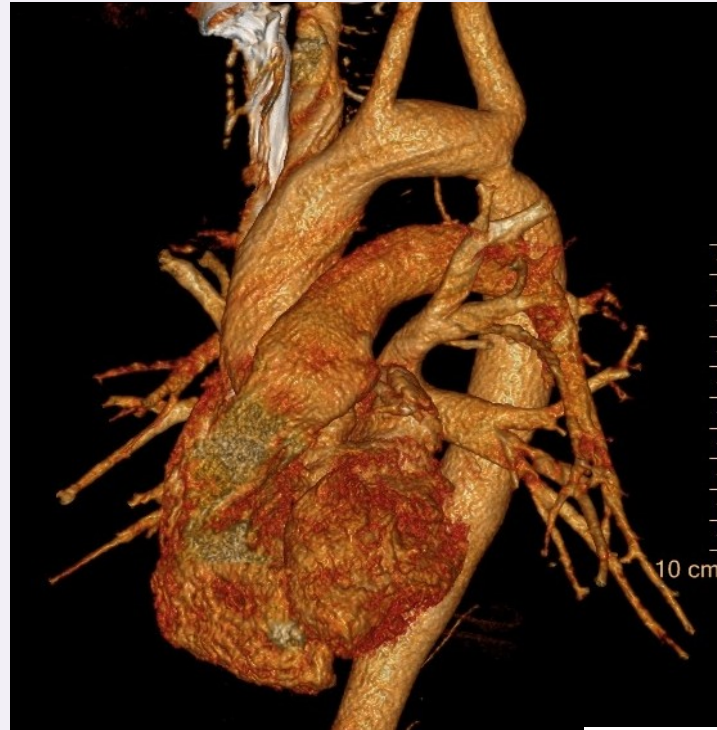
Coarctation of the aorta

5-8 % of CHD

male : female 2-5:1

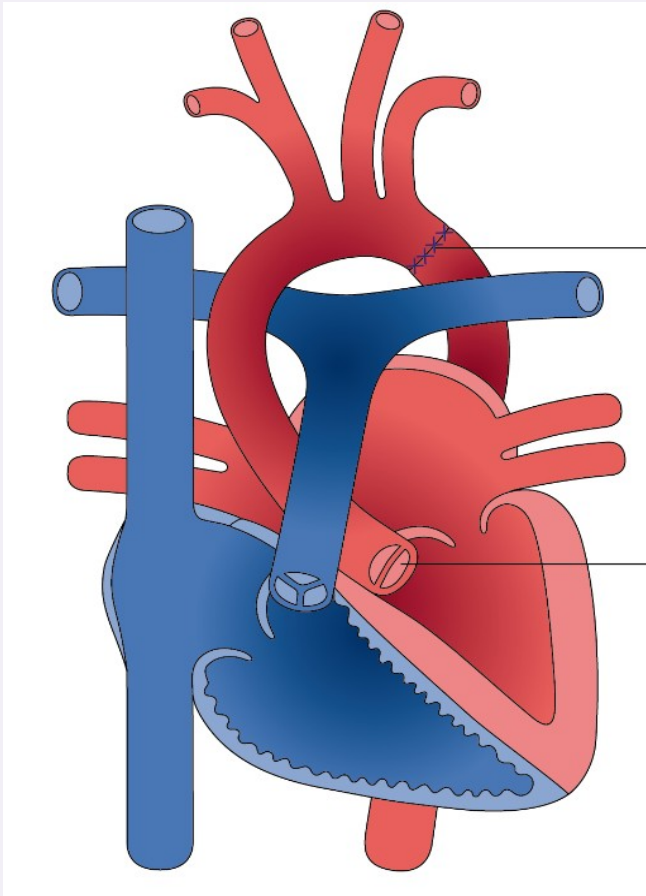
congenital narrowing of thoracic aorta after
the origin of subclavian artery

hypertension in upper part of body

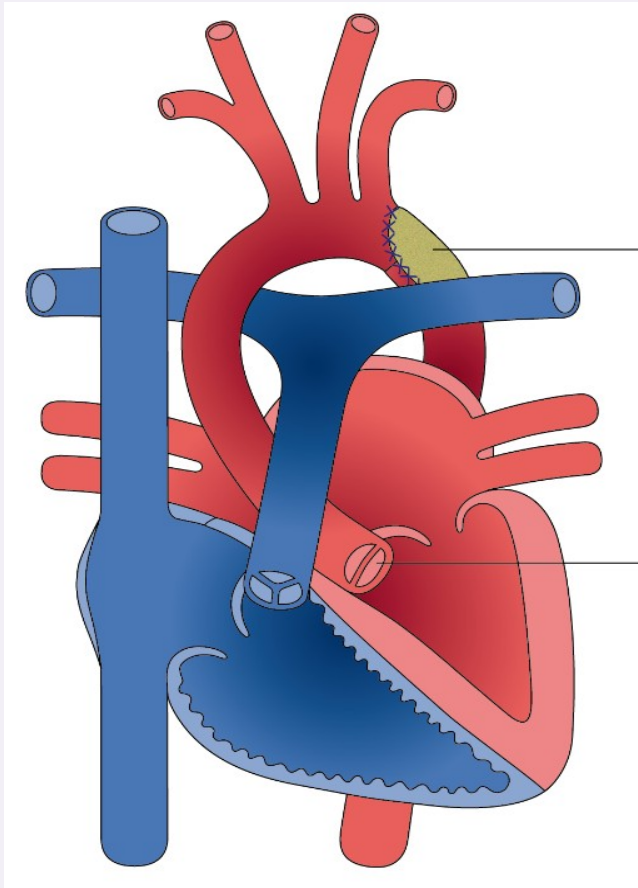


Coarctation of the aorta - surgery

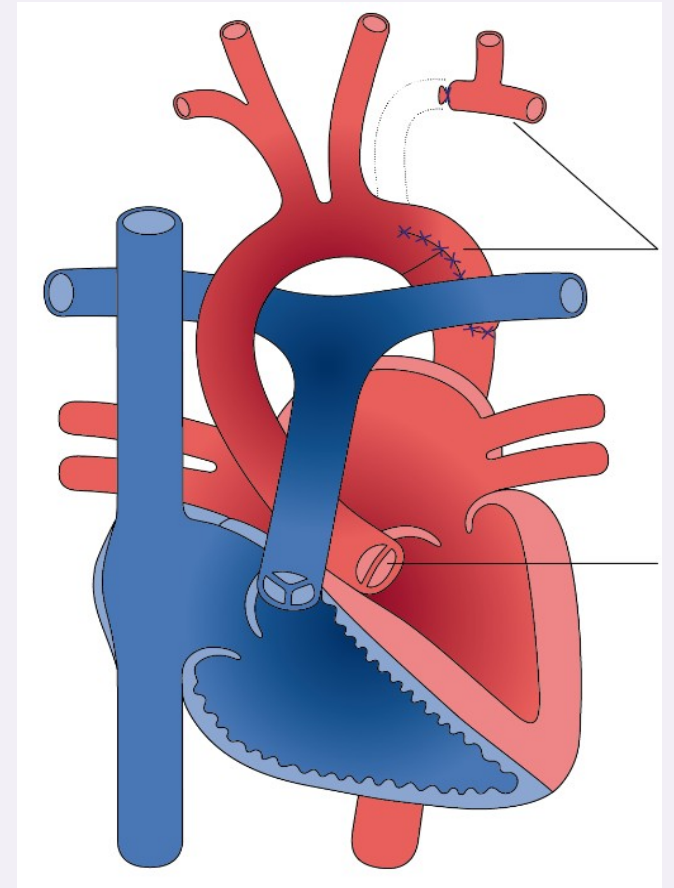
Resection + end to end anastomosis



Reconstruction with patch - Vosschulte

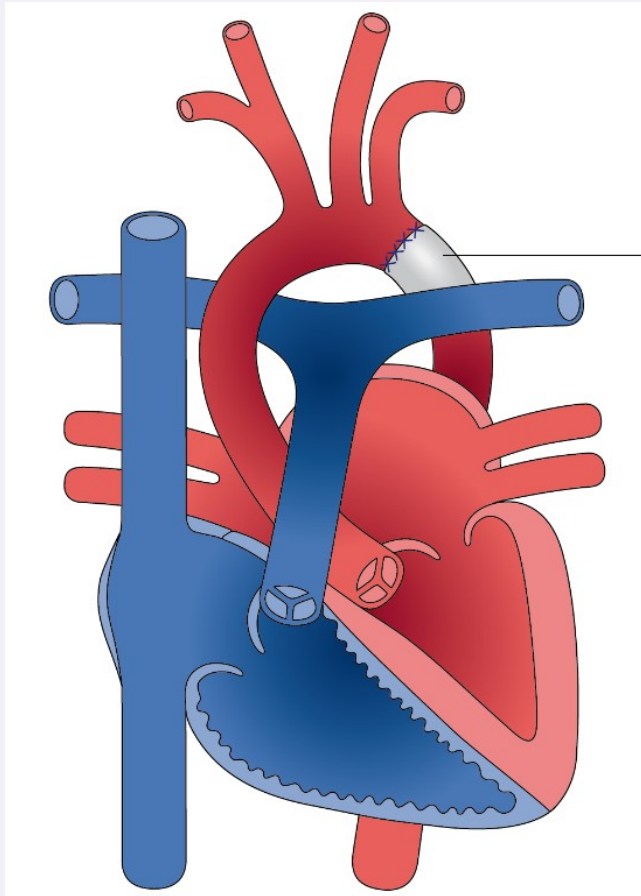


Reconstruction - Waldhausen

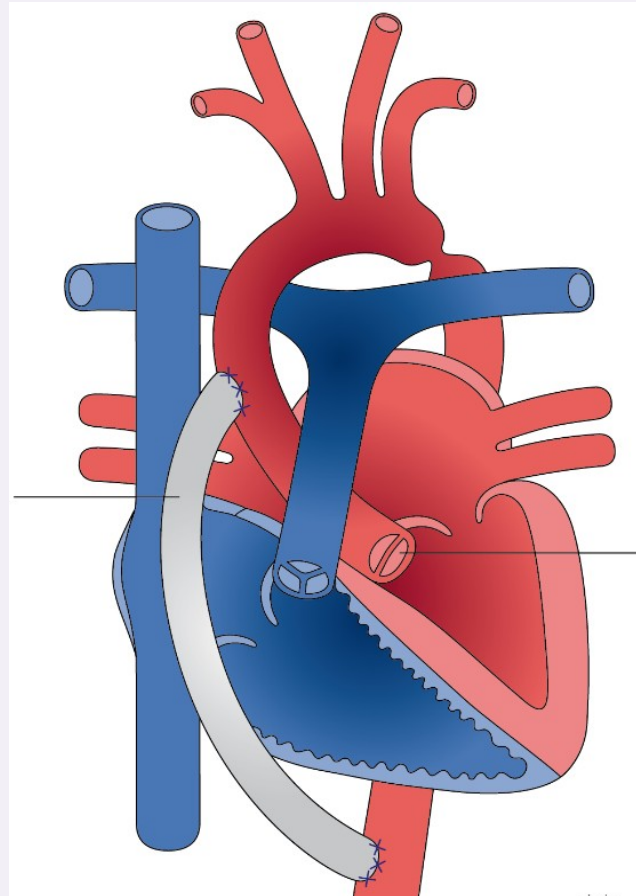


Coarctation of the aorta - surgery

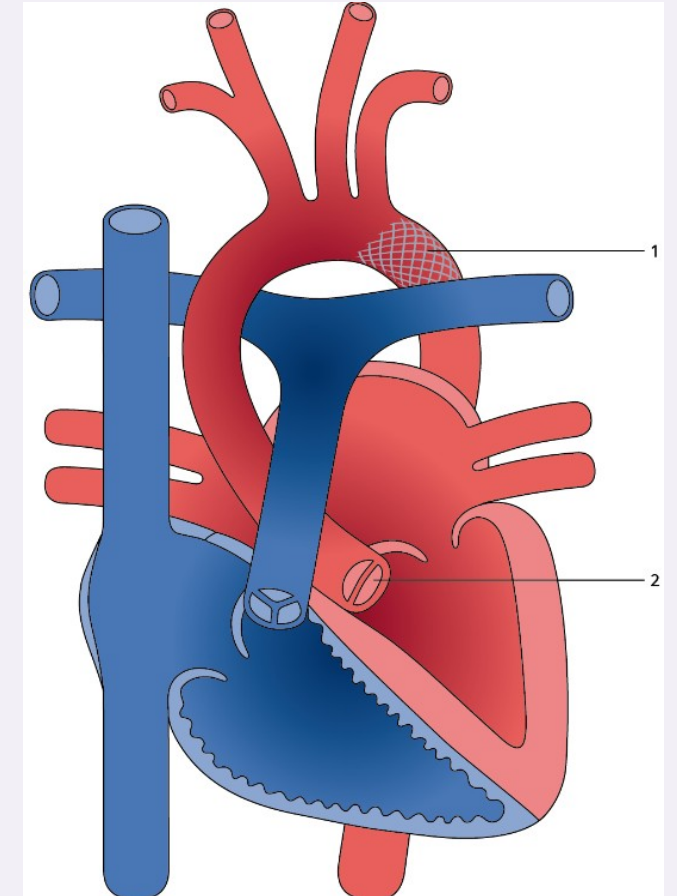
Excision + vascular prosthesis



Extraanatomic bypass



Stent/SG implantation

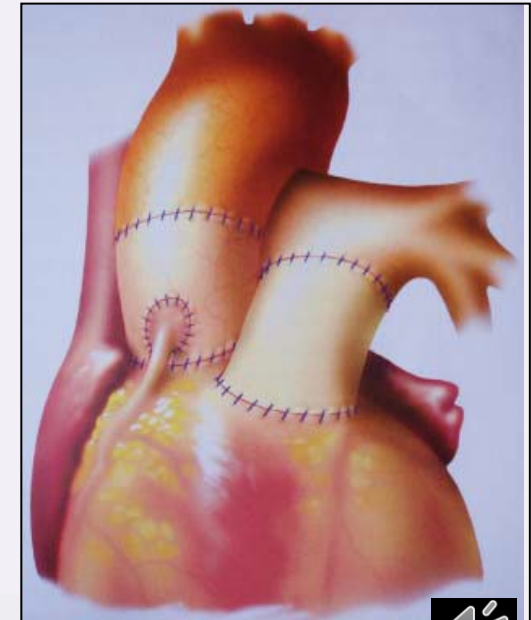
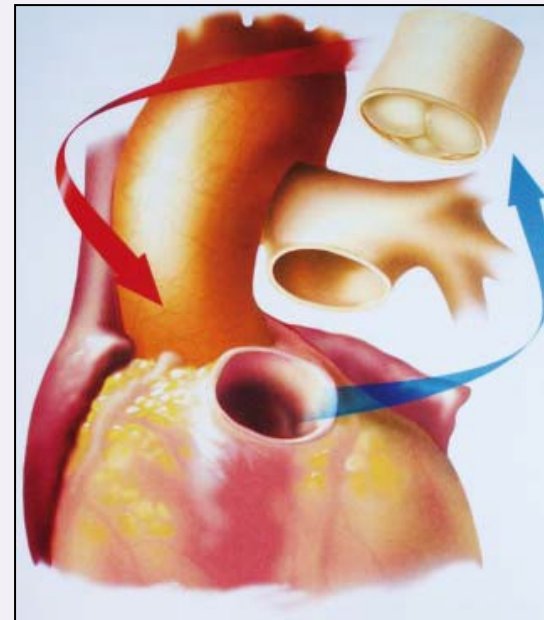
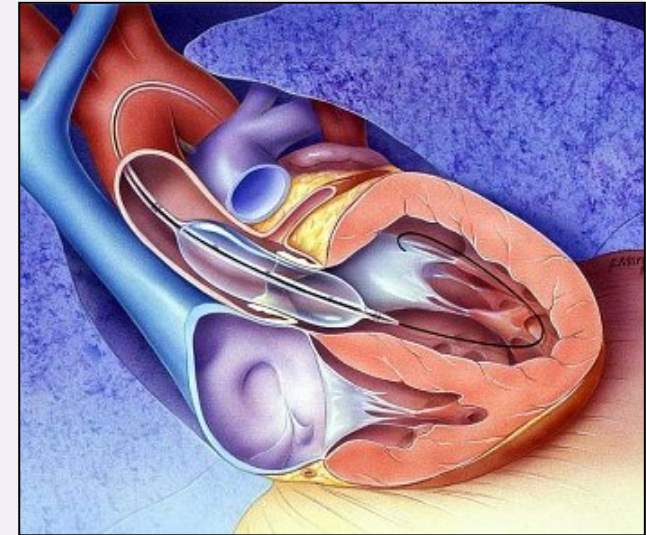


Congenital aortic valve stenosis

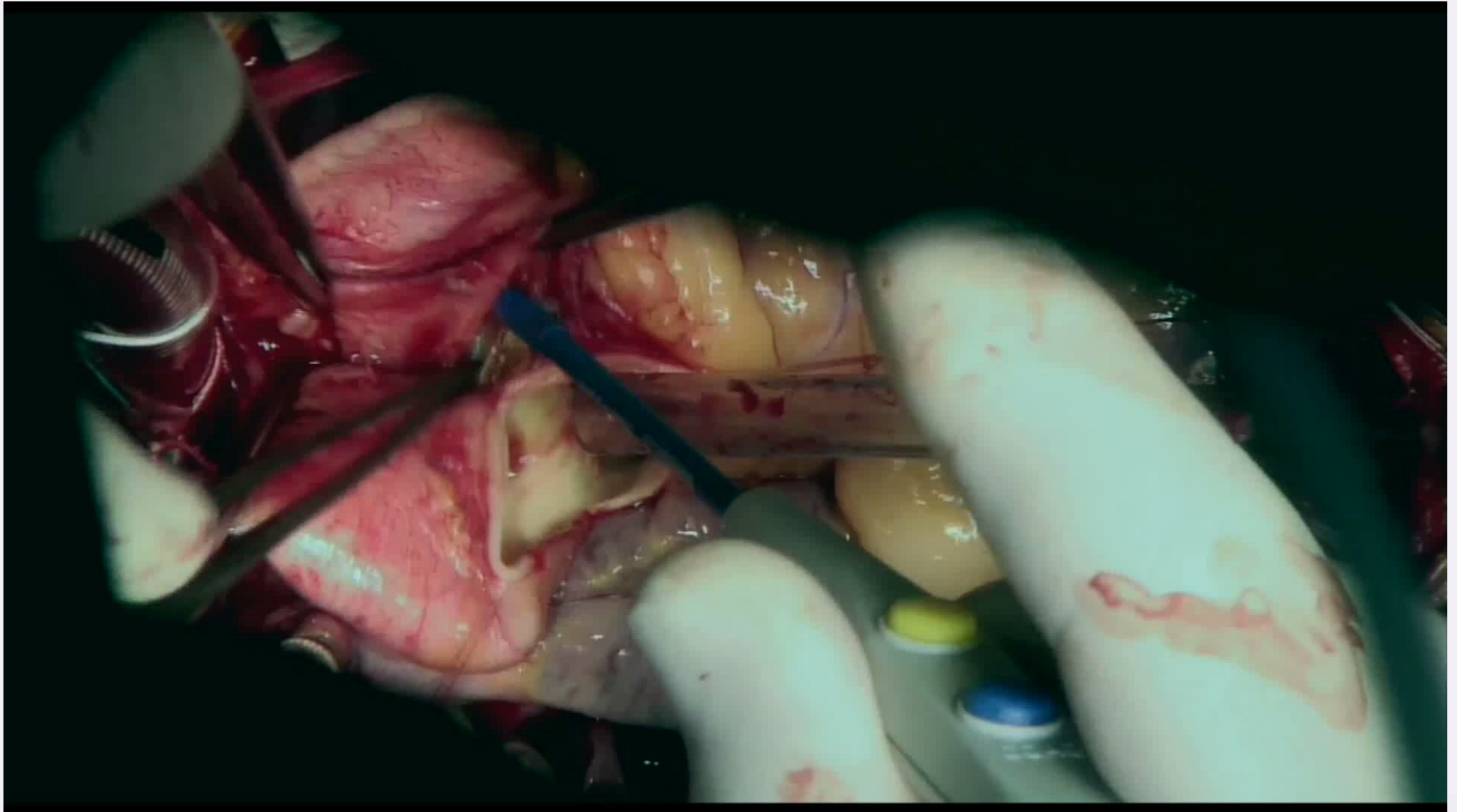
- subvalvular, valvular, supra-annular
- reduction of surgery
- delaying of aortic valve replacement

Therapy:

- catheter treatment,
- aortic valve sparing surgery
- aortic valve replacement
mechanical (biological) valve
Ross procedure



Ross operation - autograft harvesting



Heart diseases

Congenital

- without shunt

- **left-to-right shunt** - \uparrow pulmonary blood flow \rightarrow RV volume overload
 $\rightarrow \uparrow$ PVR \rightarrow RV pressure overload

- right-to-left shunt

Acquired

- ischemic heart diseases

- valve diseases

- aortic diseases

- tumors

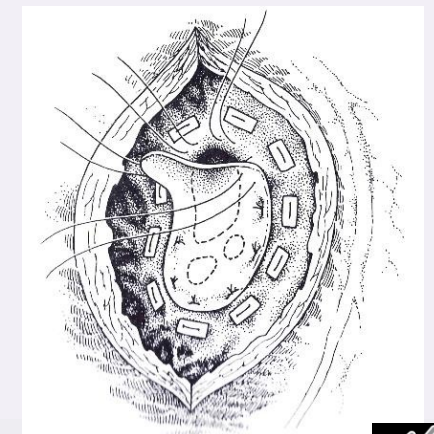
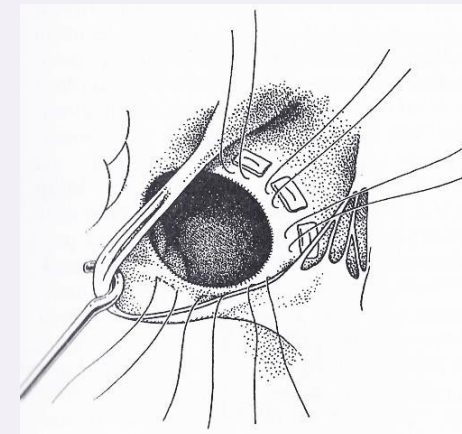
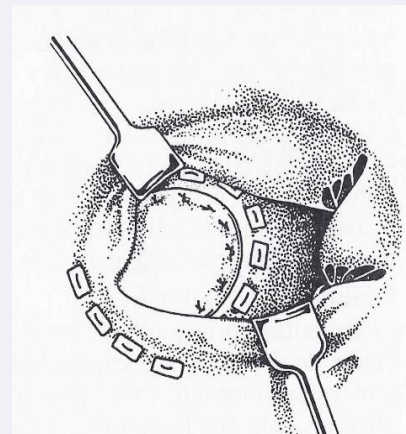
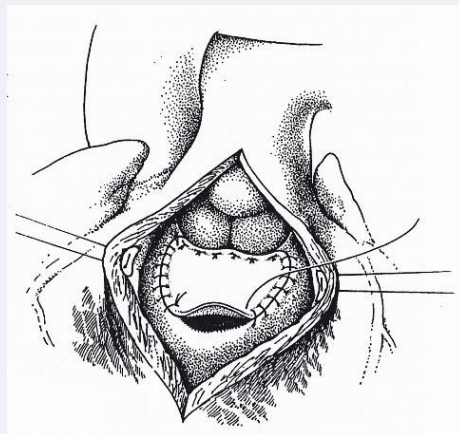
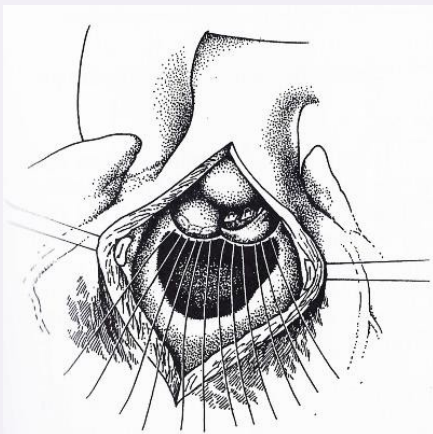
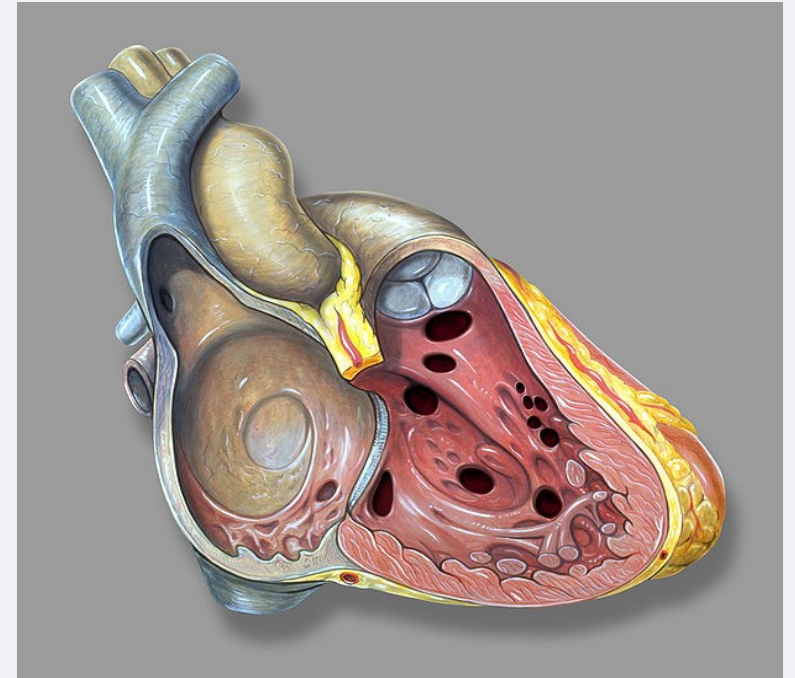
- others

- VSD
- ASD
- patent ductus arteriosus
- aortopulmonary window
- anomalous origin of the LCA from the pulmonary artery
- AV septal defect (incomplete x complete)



Ventricular septal defect

- most often CHD
- isolated x with other CHD
- blood circulation pathophysiology depends on diameter and PVR



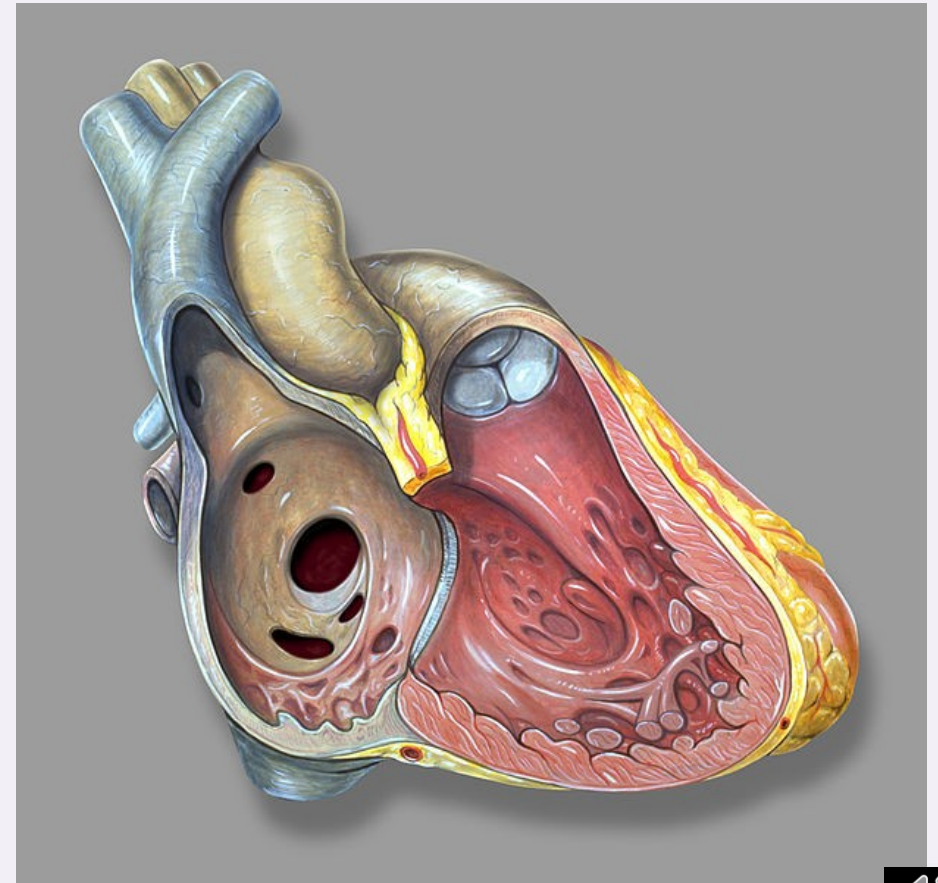
Atrial septal defect

no symptoms x large defect - weariness

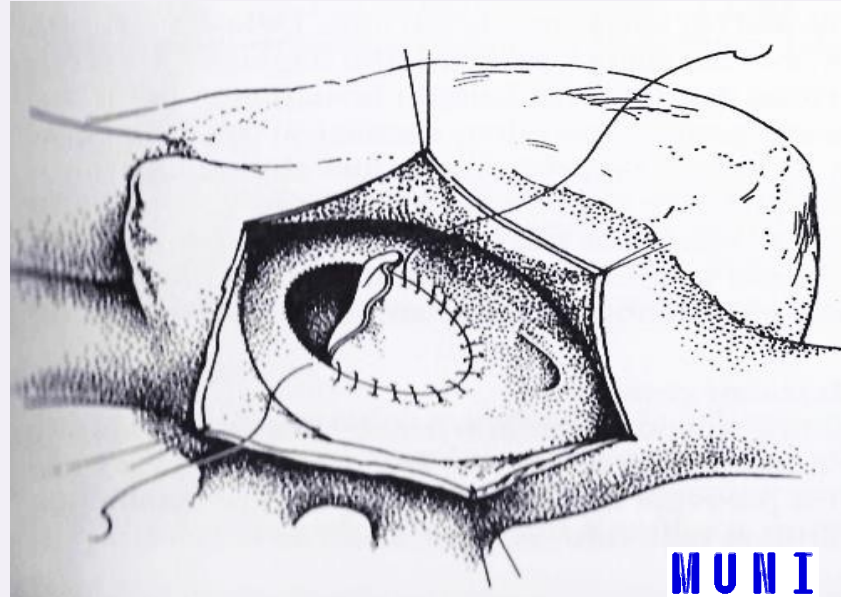
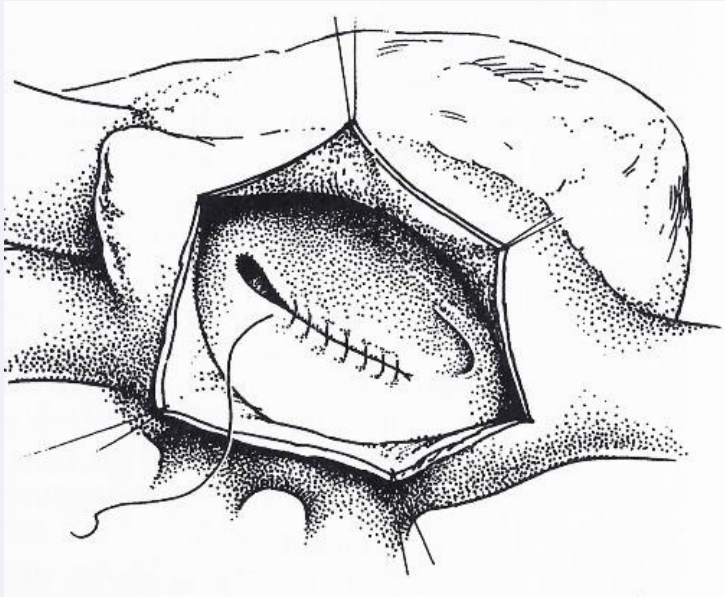
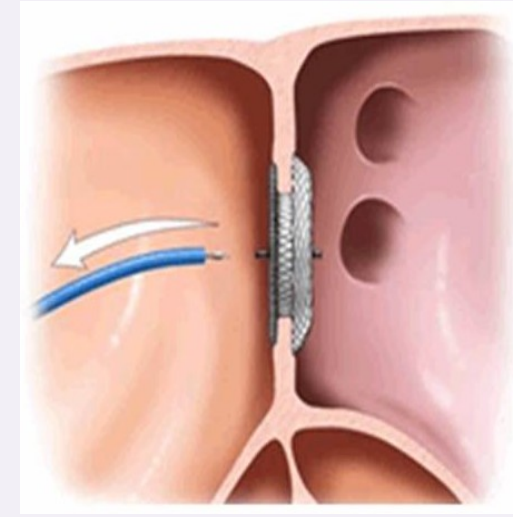
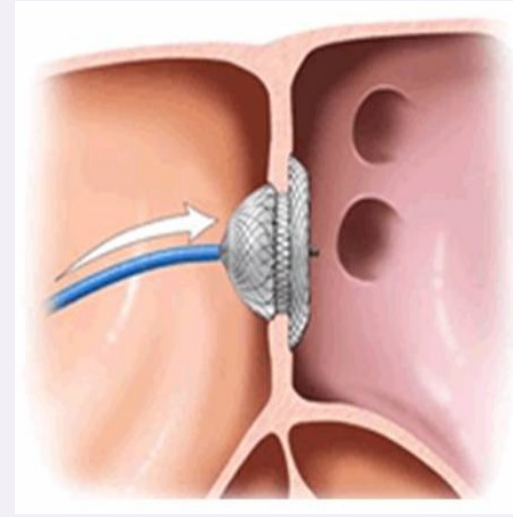
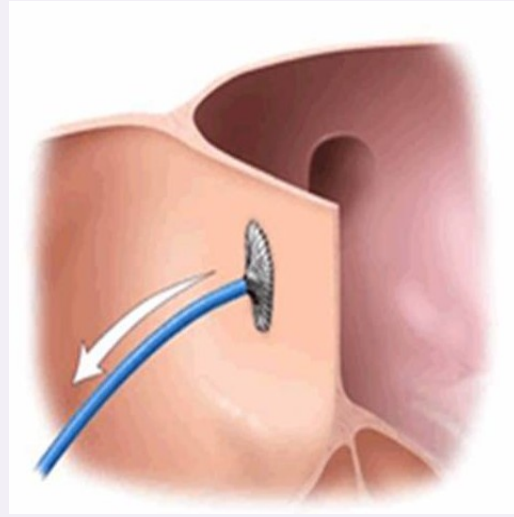
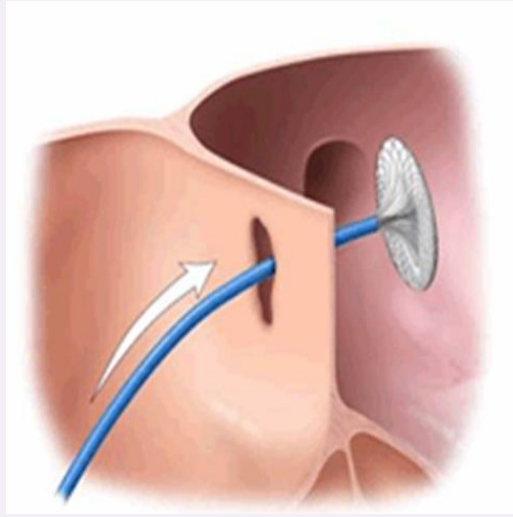
symptoms in adult – enlarging RA, RV, RV failure, arrhythmia

↑ CVP - paradoxical embolism

surgery x catheterization



Atrial septal defect - closure

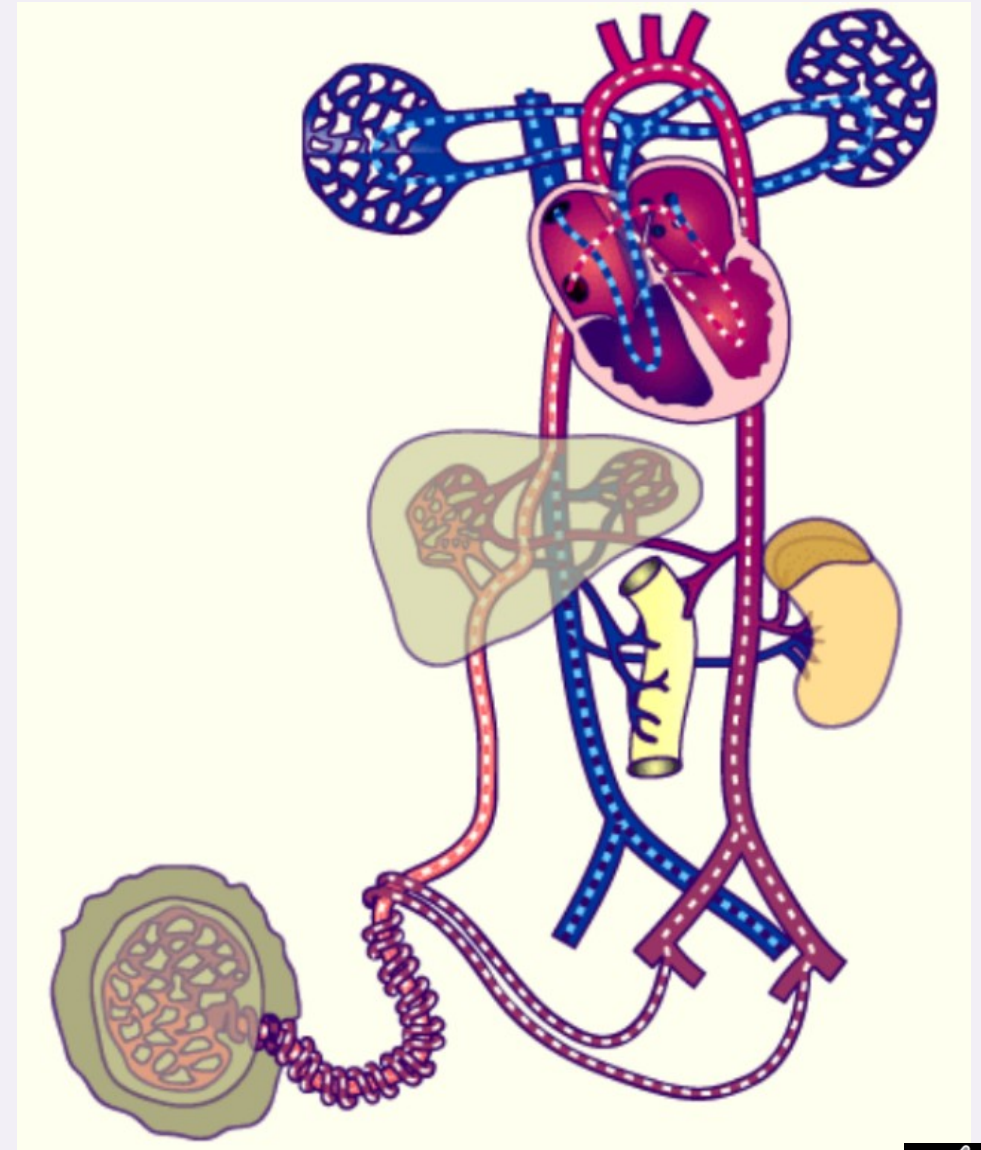
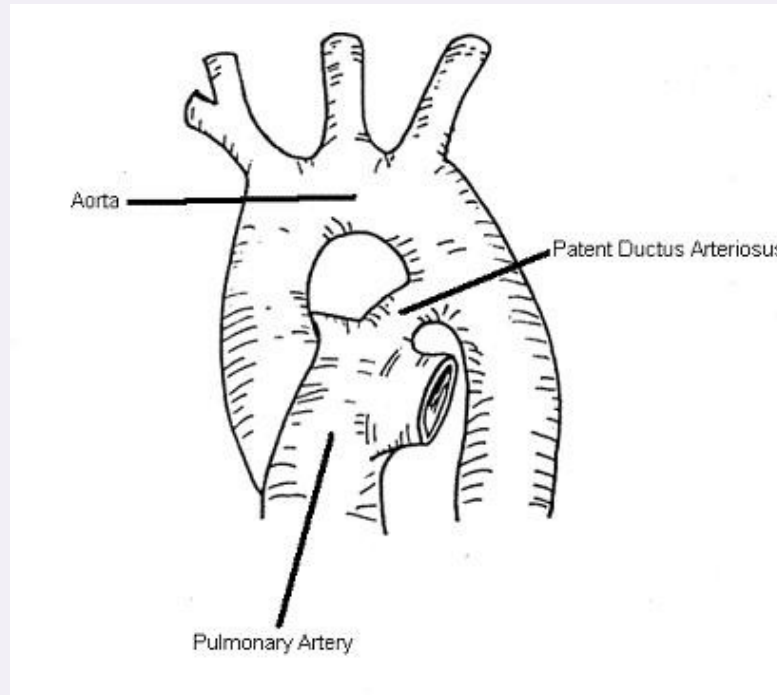


Persistent open arterial duct

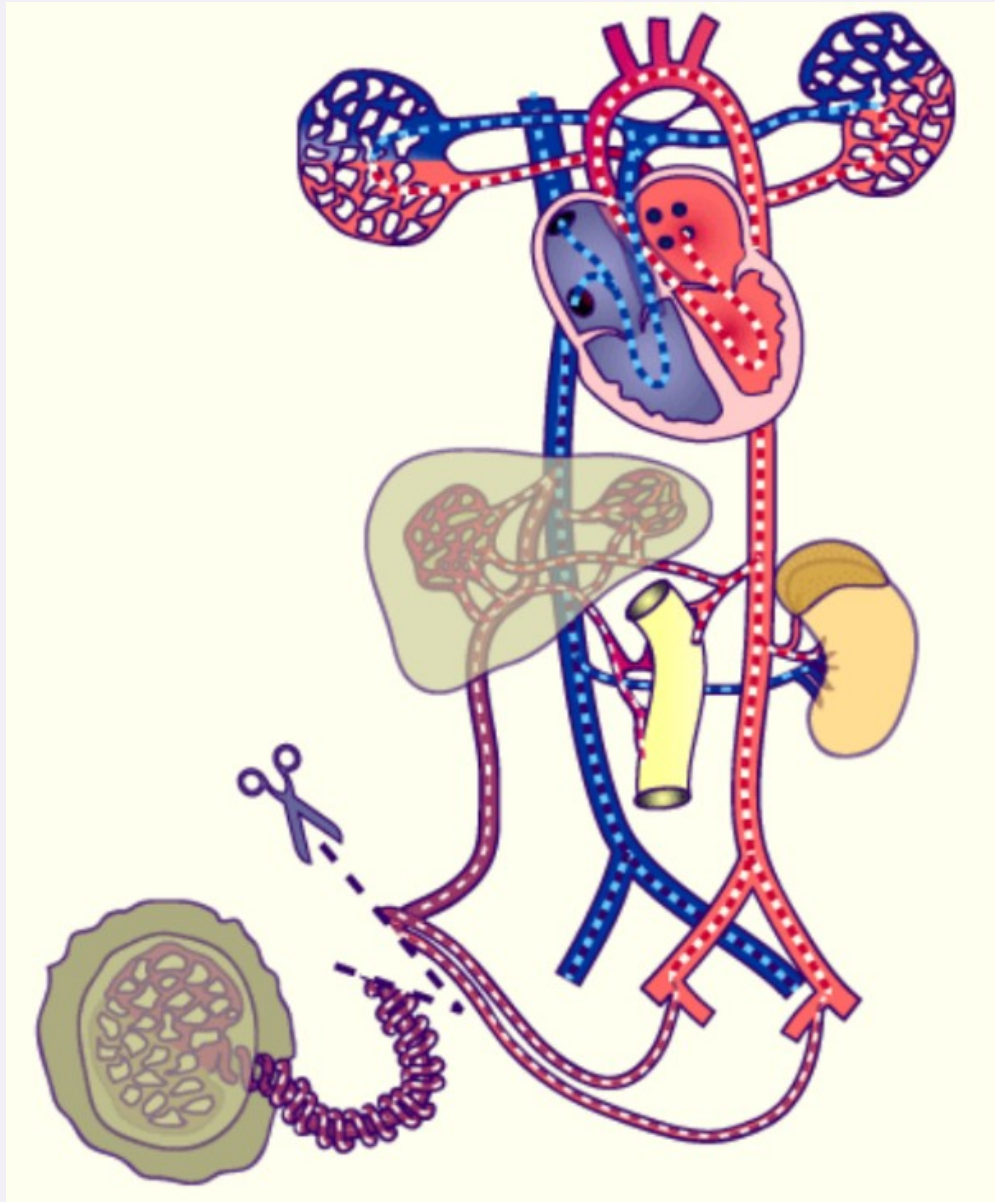
extracardiac connection between pulmonary and systemic circulation

during fetal circulation

- ↑ prostaglandins (E2, E1) → persistent connection

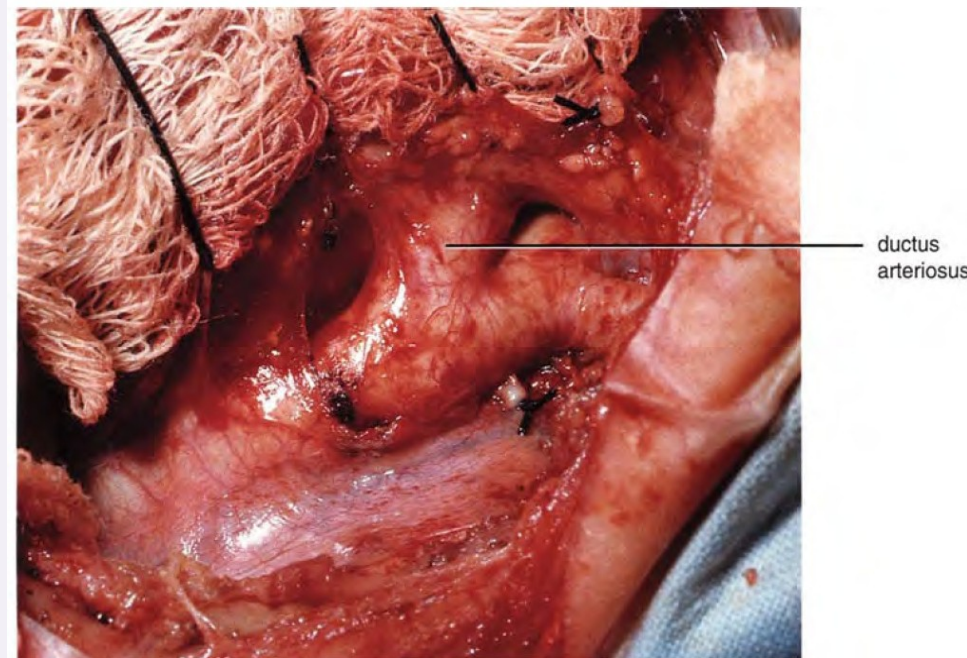


Persistent open arterial duct



after birth $\uparrow pO_2$ a $\downarrow PG$
(placental removal)

- 5-10% all congenital heart diseases
- in prematurely born 20-30%



Persistent open arterial duct (persistent ductus arteriosus)

farmacotherapy - ibuprofen - PG inhibitors

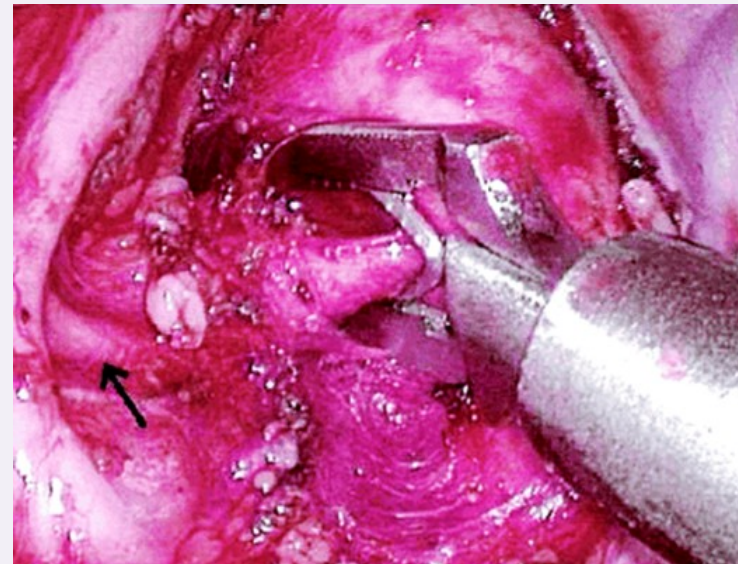
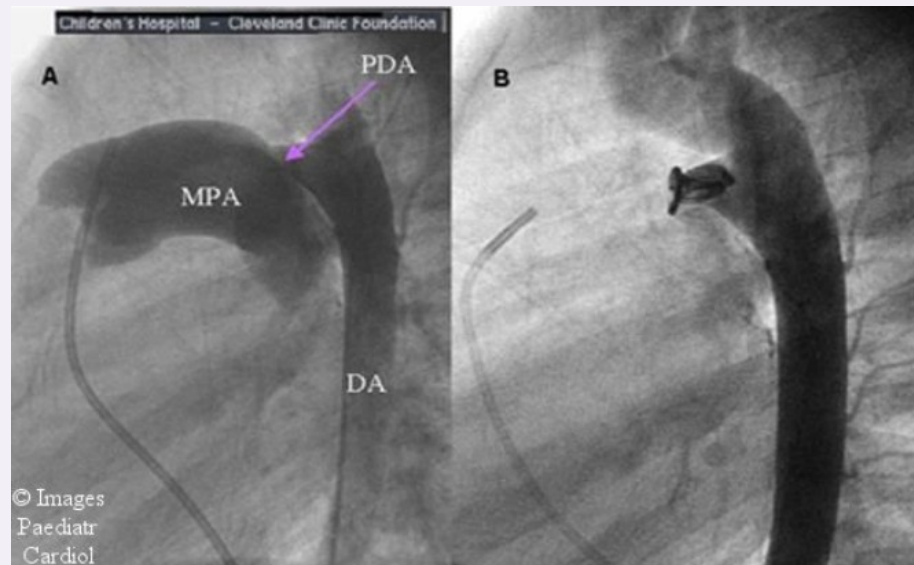
cathetrization

surgery - VATS

- „open surgery“ - thoracotomy

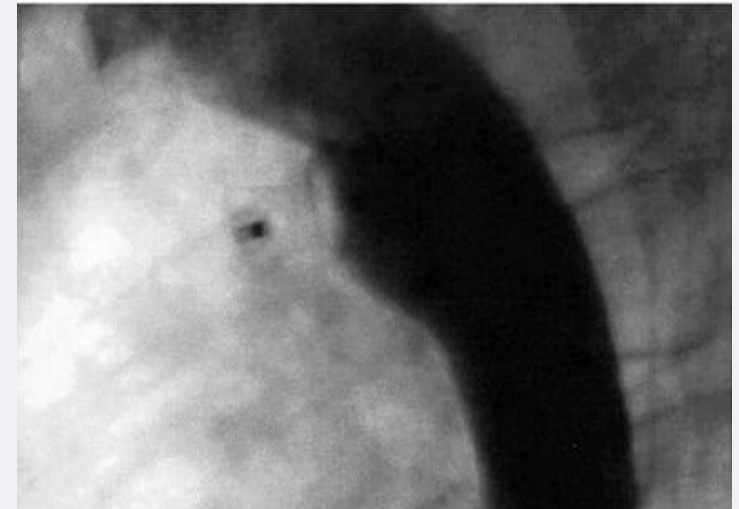
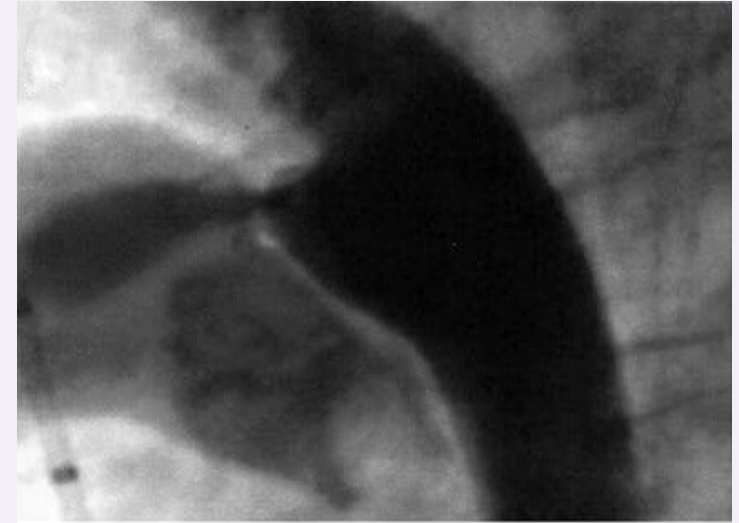
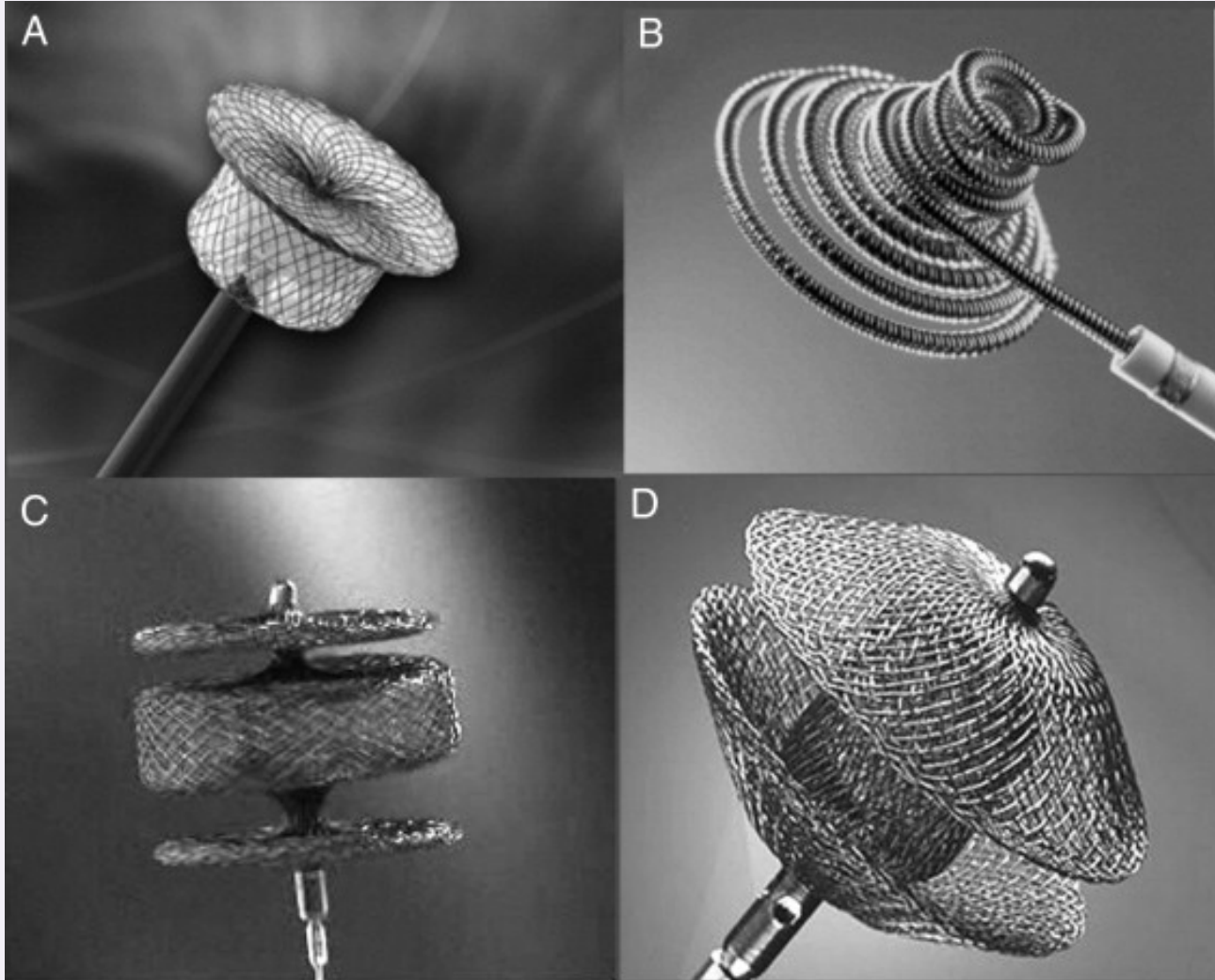
Closing is making except for disorders, when PDA is important for survival.

- PG E1 - (pulmonary stenosis, HLHS, TGA)



Types of closure devices

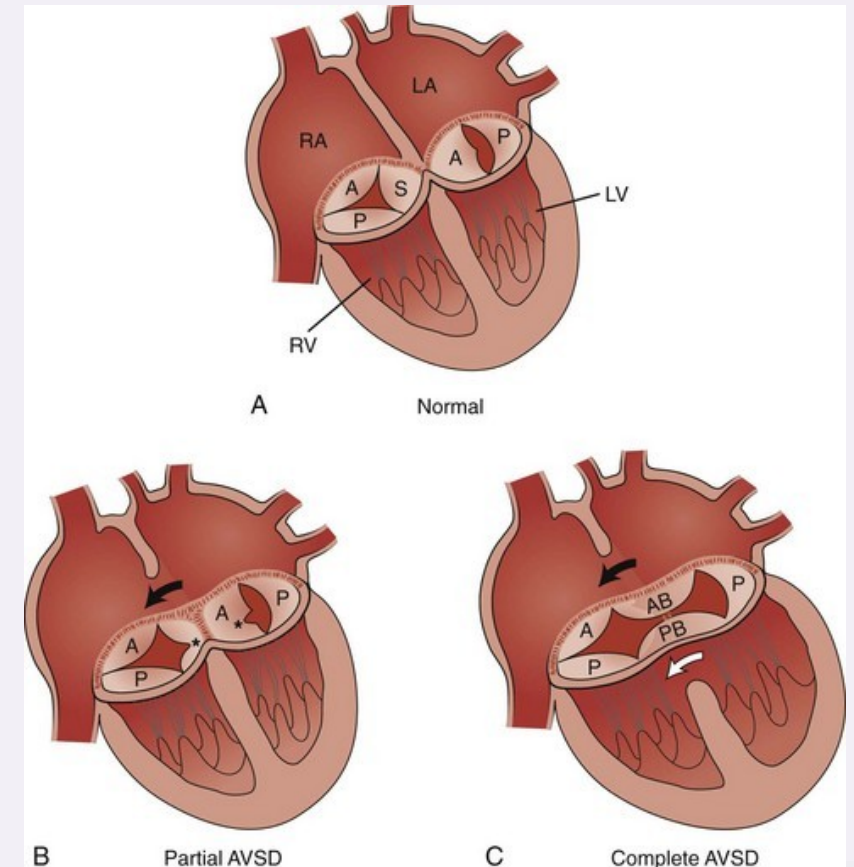
Rashkind, Amplatz, coil



AV septal defect

- deficiency of the AV septum
- caused by an abnormal fusion of the superior and inferior endocardial cushions with the mid portion of the atrial septum and the muscular portion of the ventricular

partial
complete

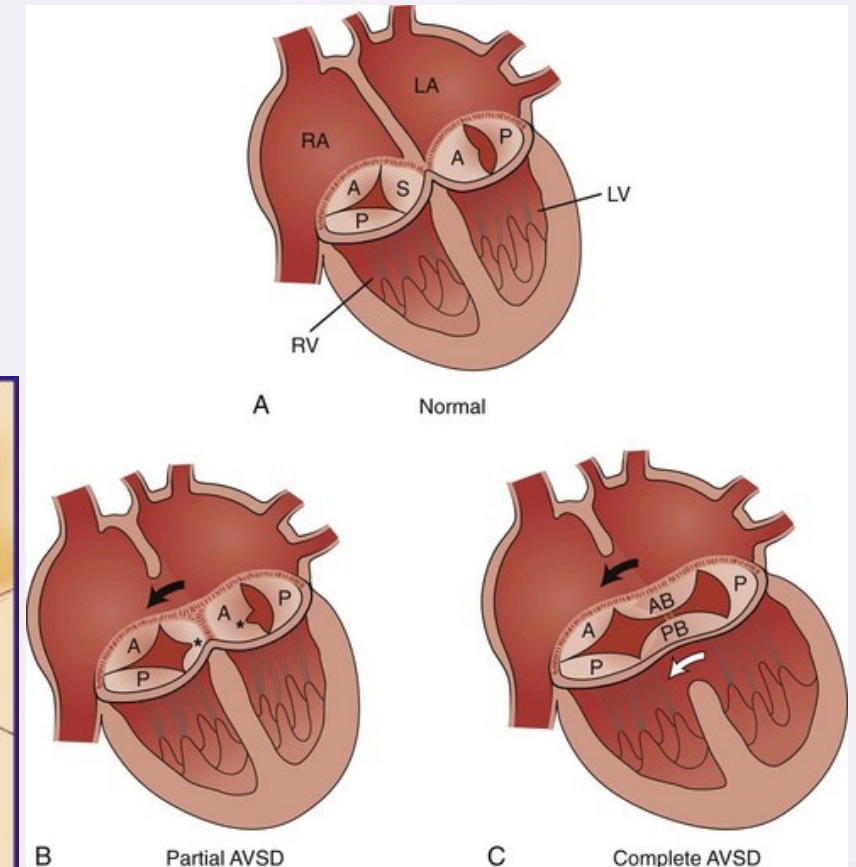
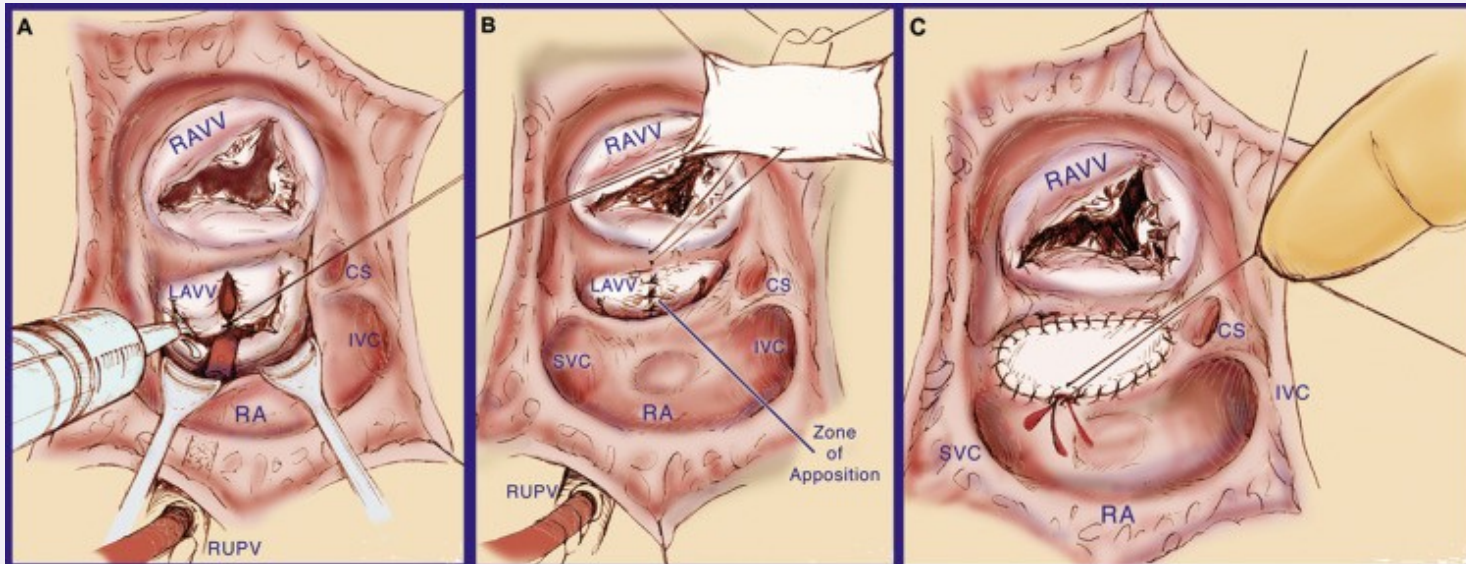


AV septal defect

- deficiency of the AV septum
- caused by an abnormal fusion of the superior and inferior endocardial cushions with the mid portion of the atrial septum and the muscular portion of the ventricular

partial

defect in the inferior part of the atrial septum usually associated with a cleft in the mitral valve that may cause the valve to leak

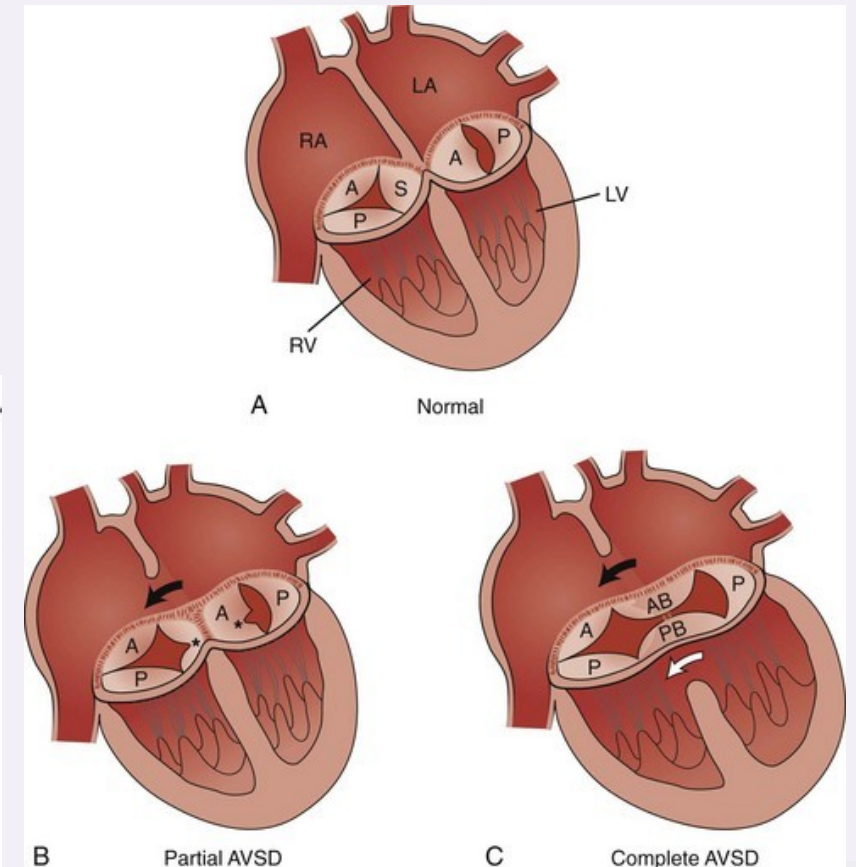
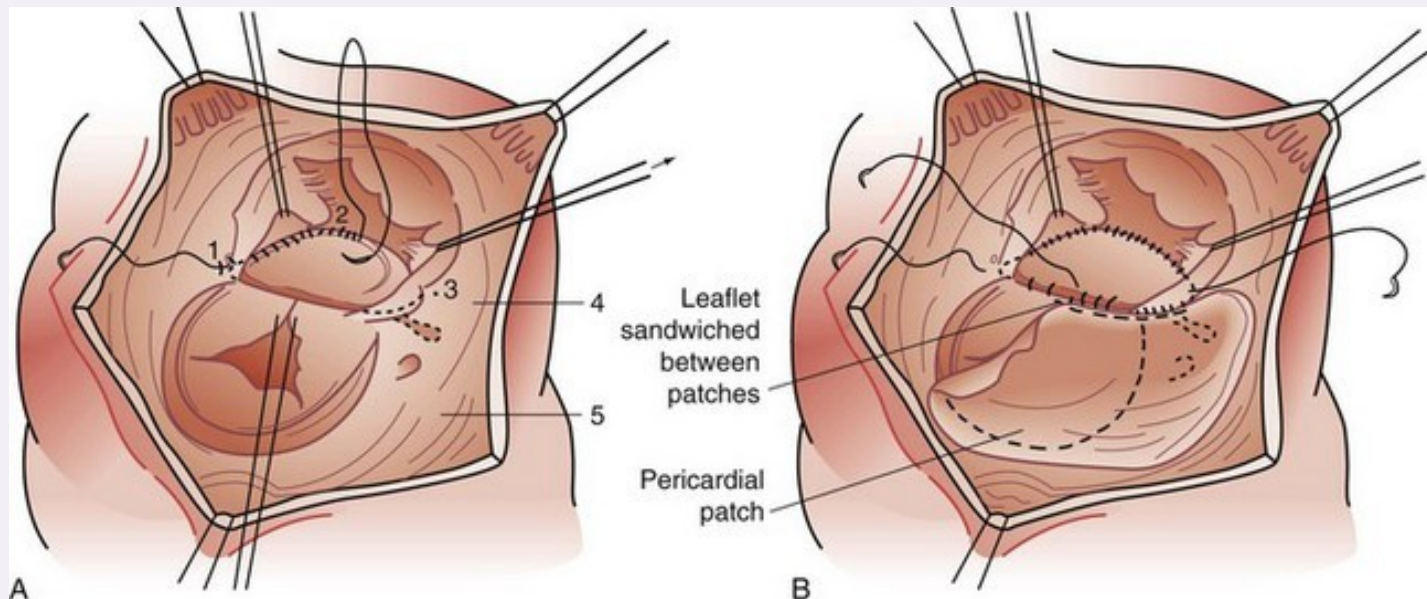


AV septal defect

- deficiency of the AV septum
- caused by an abnormal fusion of the superior and inferior endocardial cushions with the mid portion of the atrial septum and the muscular portion of the ventricular

partial
complete

defects in the atrial and ventricular septum and the AV valve remains undivided or "common"



Congenital heart diseases

Congenital

- without shunt
- left-to-right shunt
- **right-to-left shunt - cyanotic**

Acquired

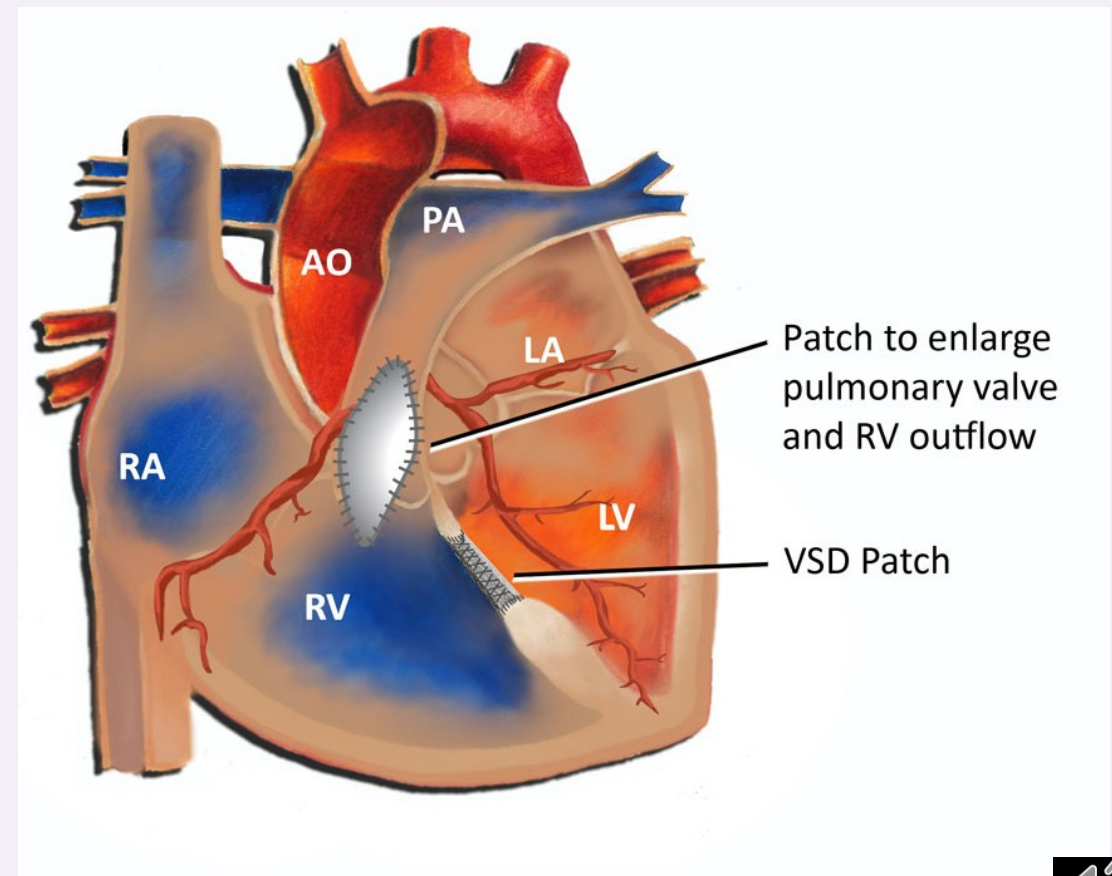
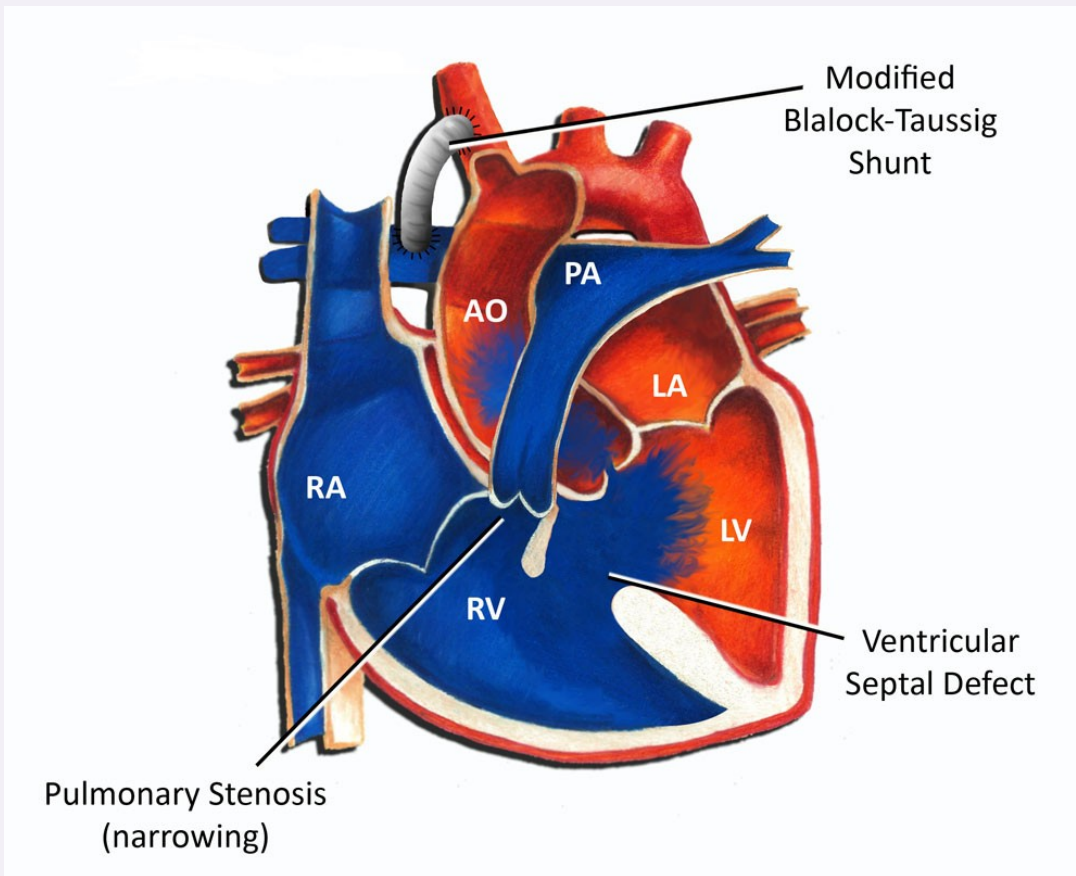
- ischemic heart diseases
- valve diseases
- aortic diseases
- tumors
- others

- tetralogy of Fallot
- TGA
- VSD with pulmonary atresia
- total anomalous pulmonary venous return
- truncus arteriosus



Tetralogy of Fallot

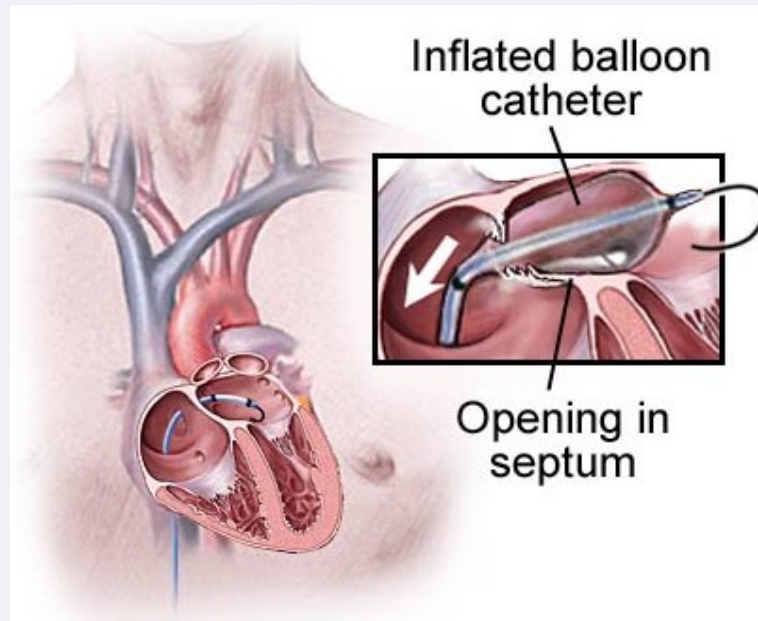
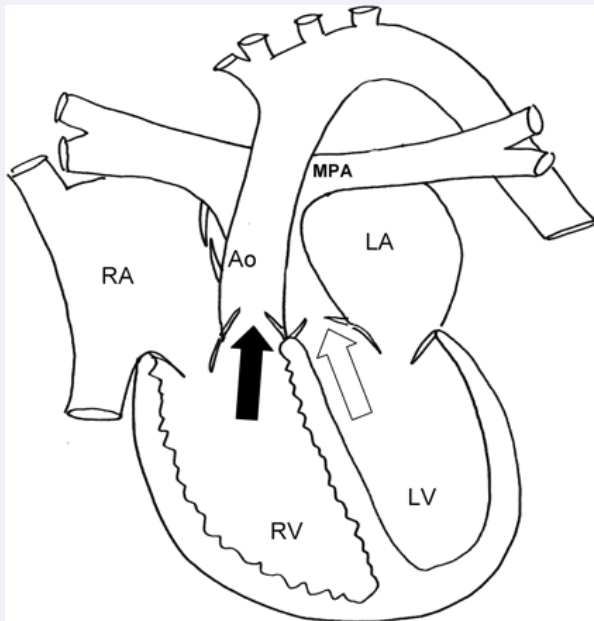
- surgery during first year
- observation
- 20% redo surgery in adult



Transposition of great arteries - dTGA

1. dextro-transposition of the great arteries (d-TGA)

- also **complete transposition of the great arteries**. The primary arteries (the aorta and the pulmonary artery) are transposed.
- **ventriculoarterial discordance with atrioventricular concordance**
- RA-Tri-RV-aorta
- LA-Mi-LV-pulmonary artery
- possibility of surviving is only due to shunts



Transposition of great arteries - ccTGA

2. levo-transposition of the great arteries (l-TGA)

also congenitally corrected transposition of the great arteries (**cc-TGA**),

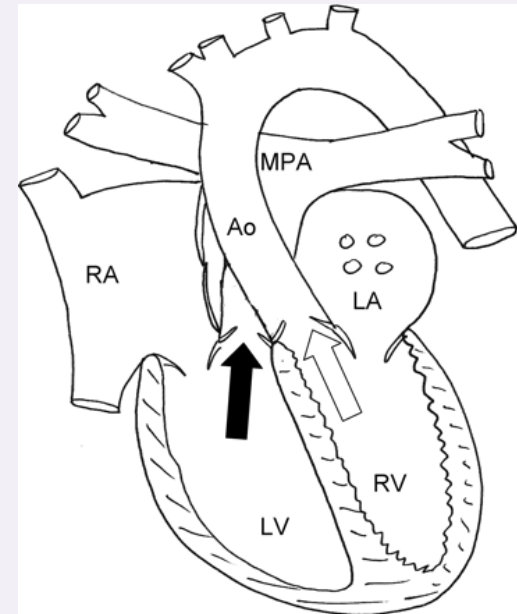
- non-cyanotic congenital heart defect (**CHD**)

- the aorta and the pulmonary artery are transposed

- morphological left and right ventricles are also transposed. This condition is described as **atrioventricular discordance (ventricular inversion) with ventriculoarterial discordance**

- RA-Mi-LV-pulmonary artery

- LA-Tri-RV-aorta



Problem? **The RV is the systemic ventricle!**

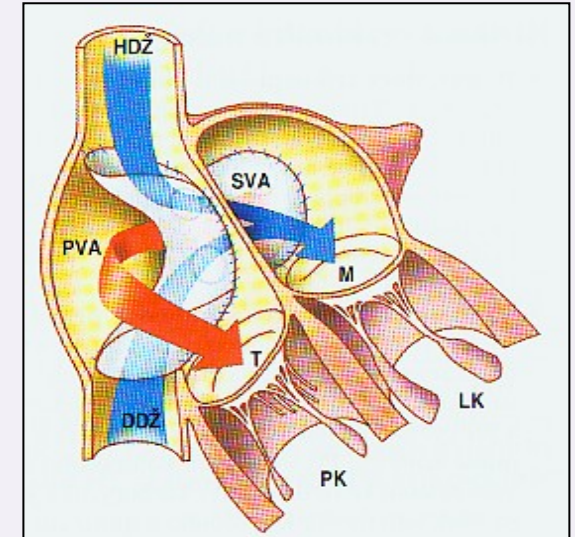
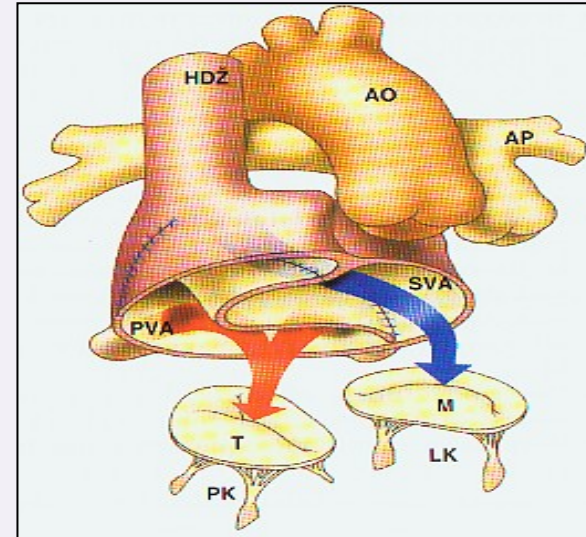
Transposition of great arteries

Follow-up...., redo surgery

- Senning, Mustard

after 30 years - RV dysfunction,
TriR, arrhythmia

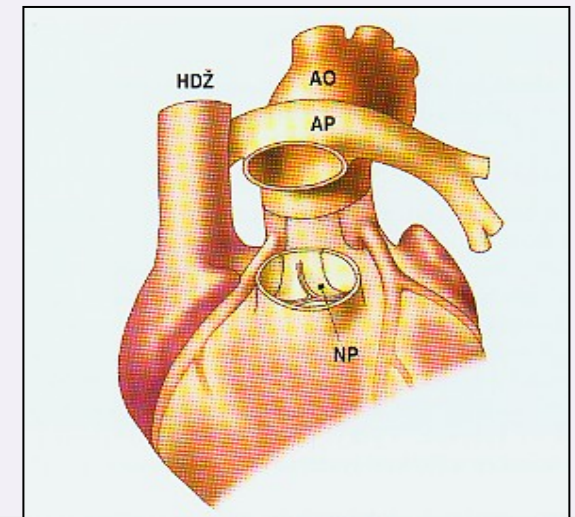
→ heart transplantation



- switch Jatene

supravalvular AoS, pulmonary stenosis;

neo-aortic root dilatation; coronary artery stenosis



Acquired heart diseases

Congenital

- without shunting
- left to right shunt
- right to left shunt

Acquired

- **ischemic heart diseases**
- **valve diseases**
- **aortic diseases**
- **tumors**
- **others**

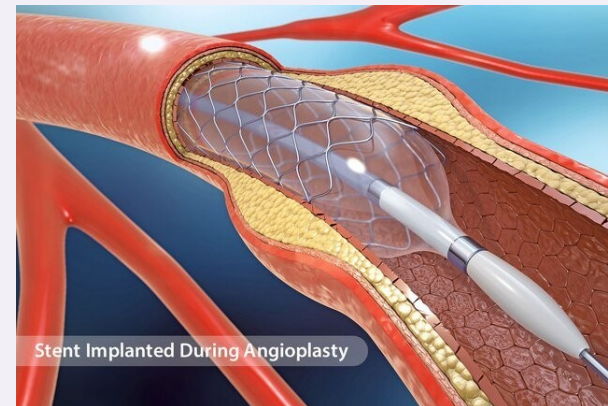


IHD – risk factors, signs, symptoms, therapy

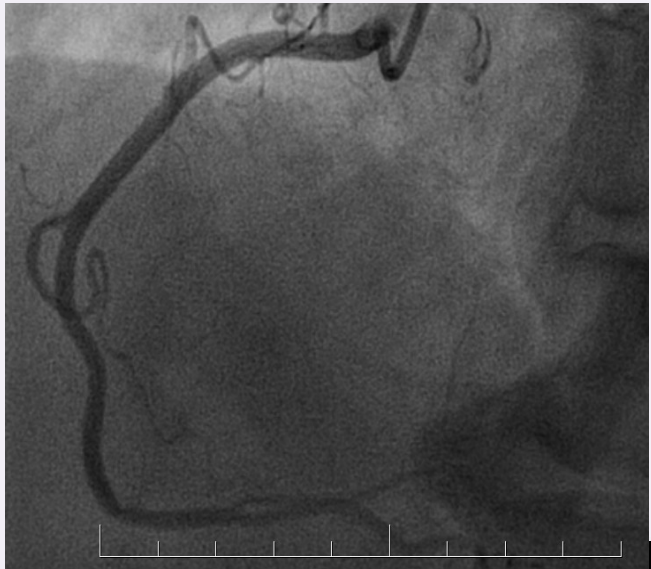
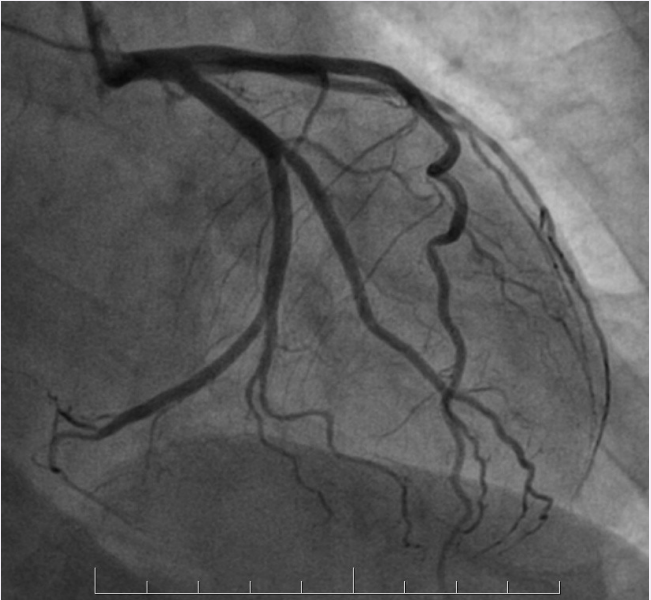
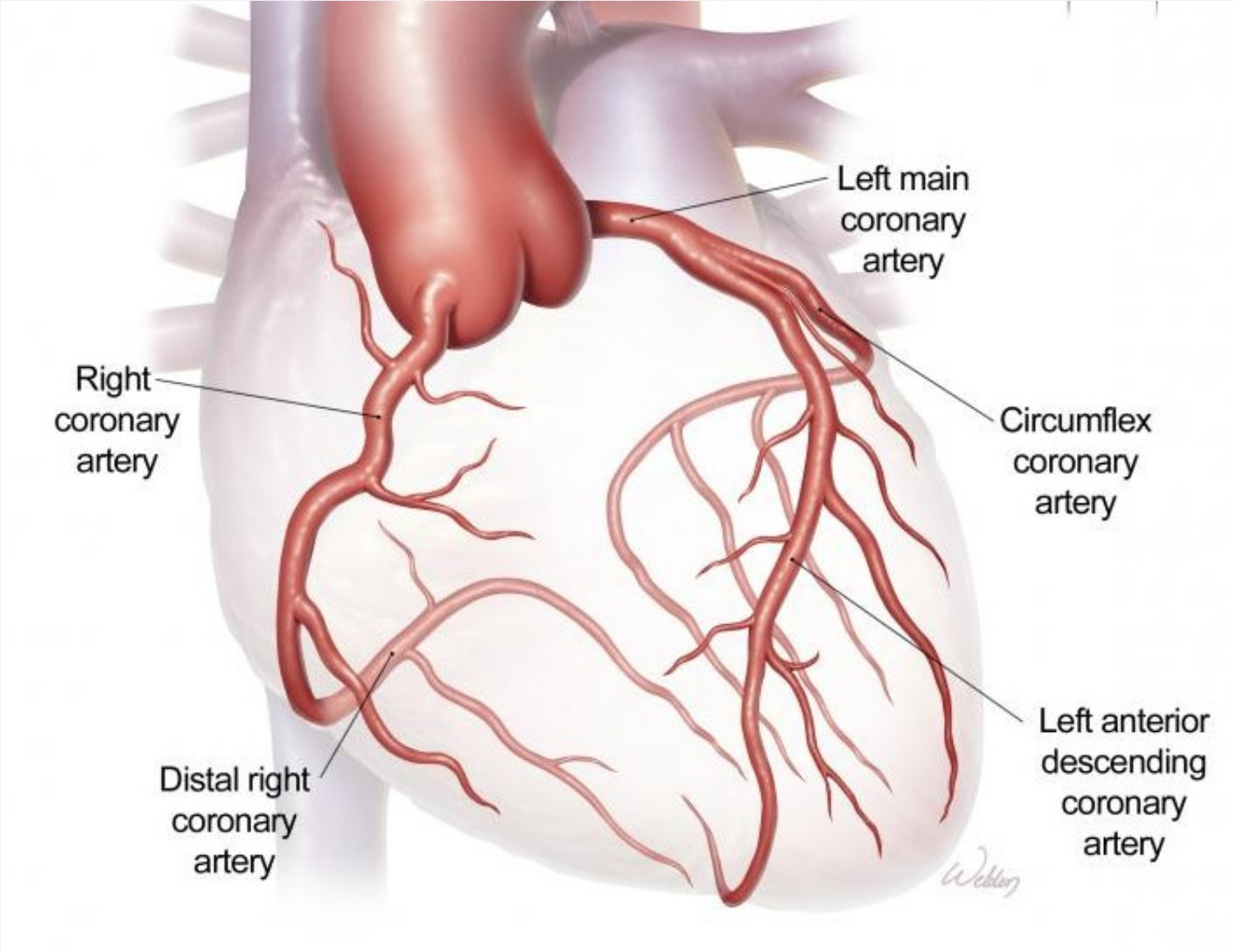
- hypertension
 - diabetes
 - obesity
 - smoking
 - hyperlipoproteinemia
 - ...
-
- no symptoms
 - angina pectoris
 - myocardial infarction
 - heart failure, sudden death

PREVENTION!!!

- drugs
- percutaneous coronary intervention
- surgical revascularization
- combination
- heart transplantation



Coronary arteries



Coronarogram – ischemic heart disease



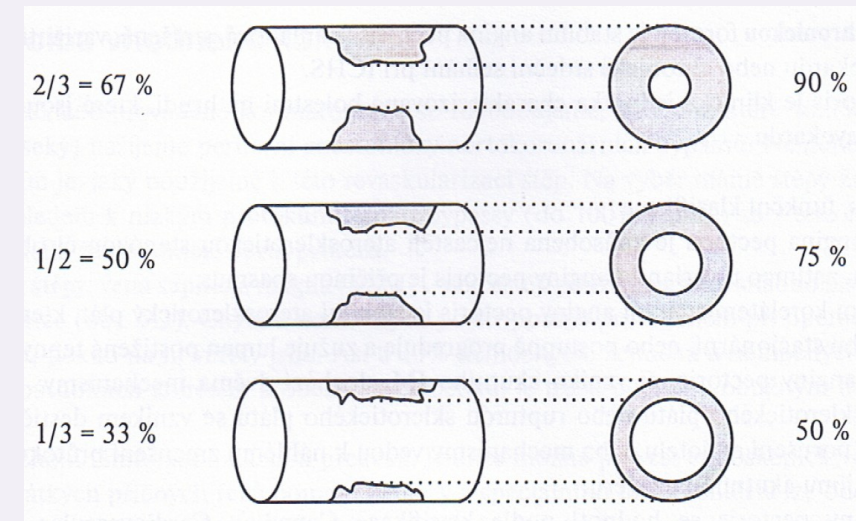
IHD – indication for surgical treatment

Clinical

- stable angina pectoris
- instable angina
- MI without possibility of intervention
- postinfarction angina

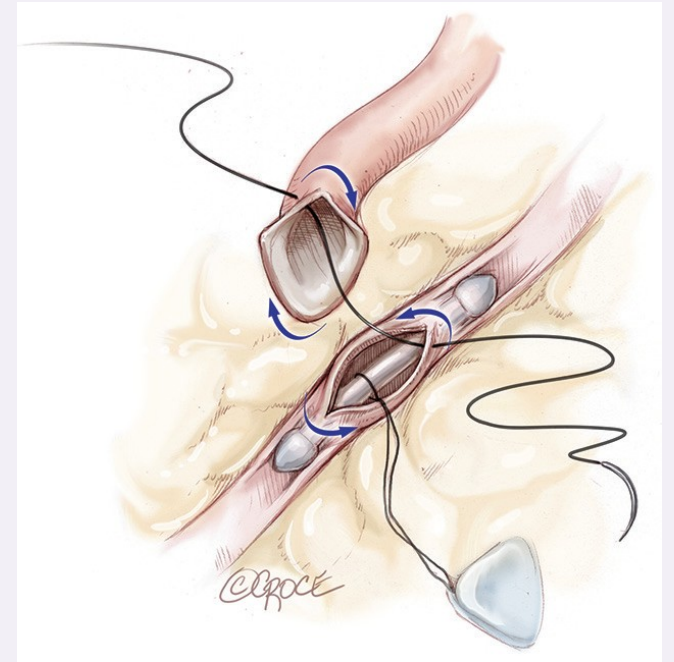
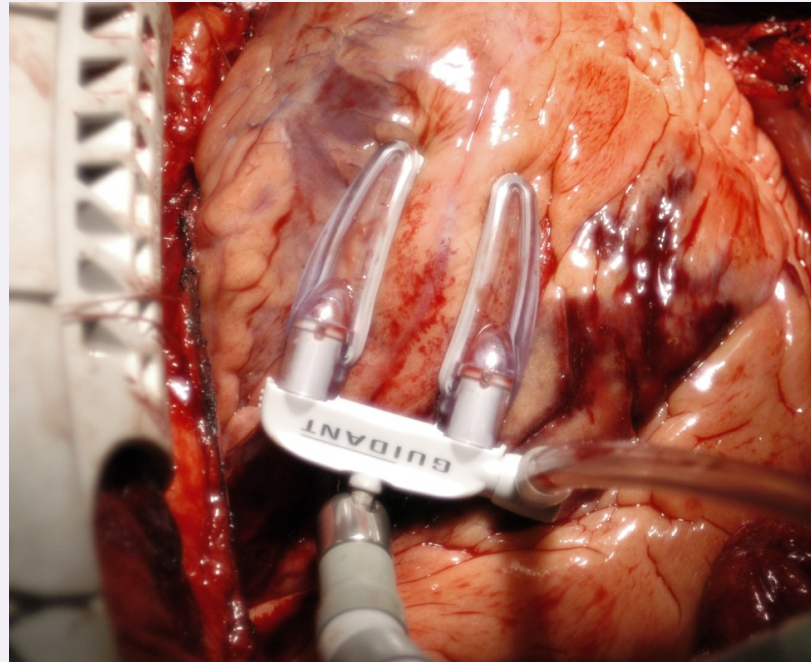
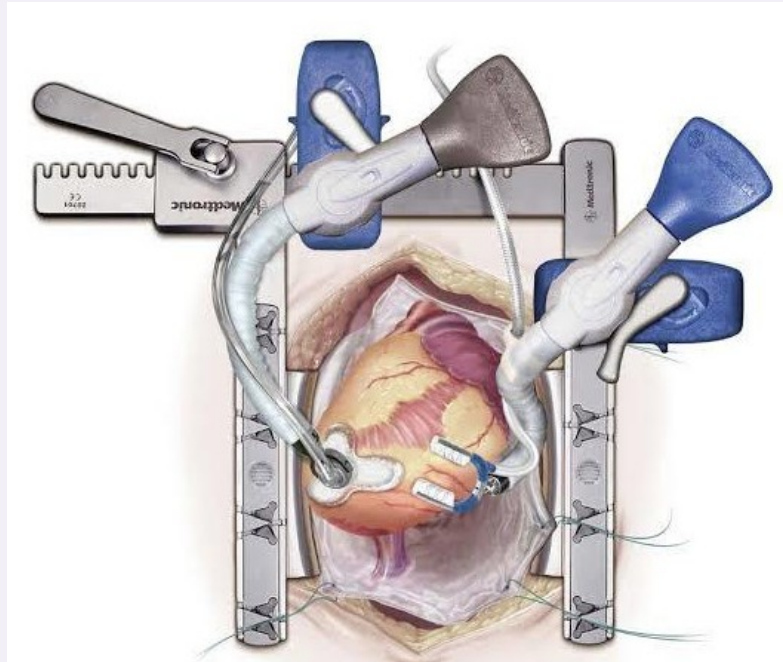
Anatomical

- number of arteries with stenosis
(left main coronary artery, one, two, three arteries...)
- grade and localization of coronary artery stenosis
- possibility of surgical treatment
(diffuse coronary artery disease, artery diameter, myocardial viability)



IHD – surgical treatment options

without C-P bypass – „off-pump“ X with C-P bypass



sternotomy
minithoracotomy
endoscopic
robotic



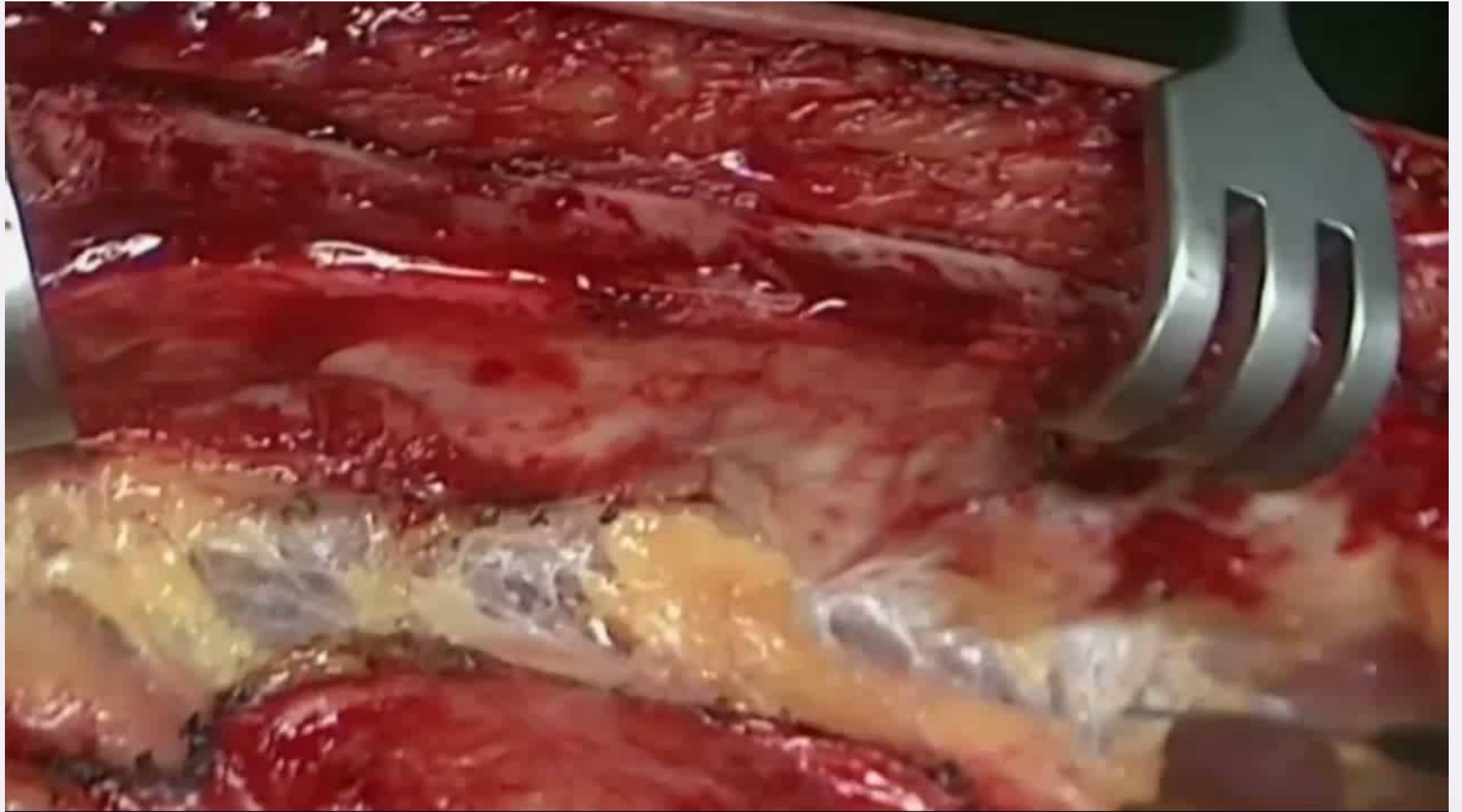
Choice of conduits for coronary artery bypass

Arterial

- LITA (a. thoracica int. l. sin) – 10 years patency 90-95%
- RITA



LIMA harvesting



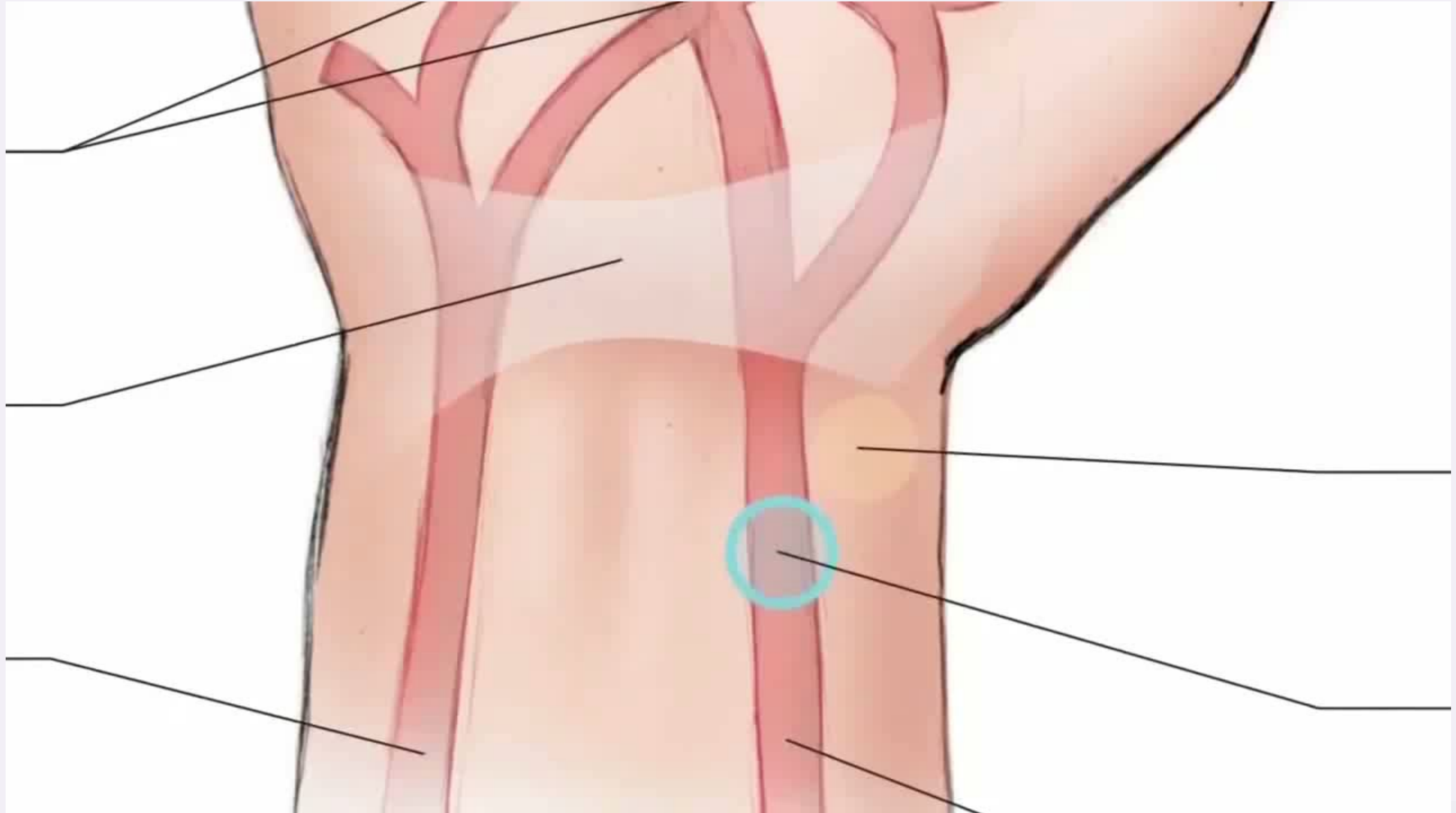
Choice of conduits for coronary artery bypass

Arterial

- LITA (a. thoracica int. l. sin) – 10 years patency 90-95%
- RITA
- radial artery



Radial artery – Allen's test



Choice of conduits for coronary artery bypass

Arterial

- LITA (a. thoracica int. l. sin) – 10 years patency 90-95%
- RITA
- radial artery
- a. gastroepiploica dx., a. epigastrica inf.



Choice of conduits for coronary artery bypass

Arterial

- LITA (a. thoracica int. l. sin) – 10 years patency 90-95%
- RITA
- radial artery
- a. gastroepiploica dx., a. epigastrica inf.

Venous

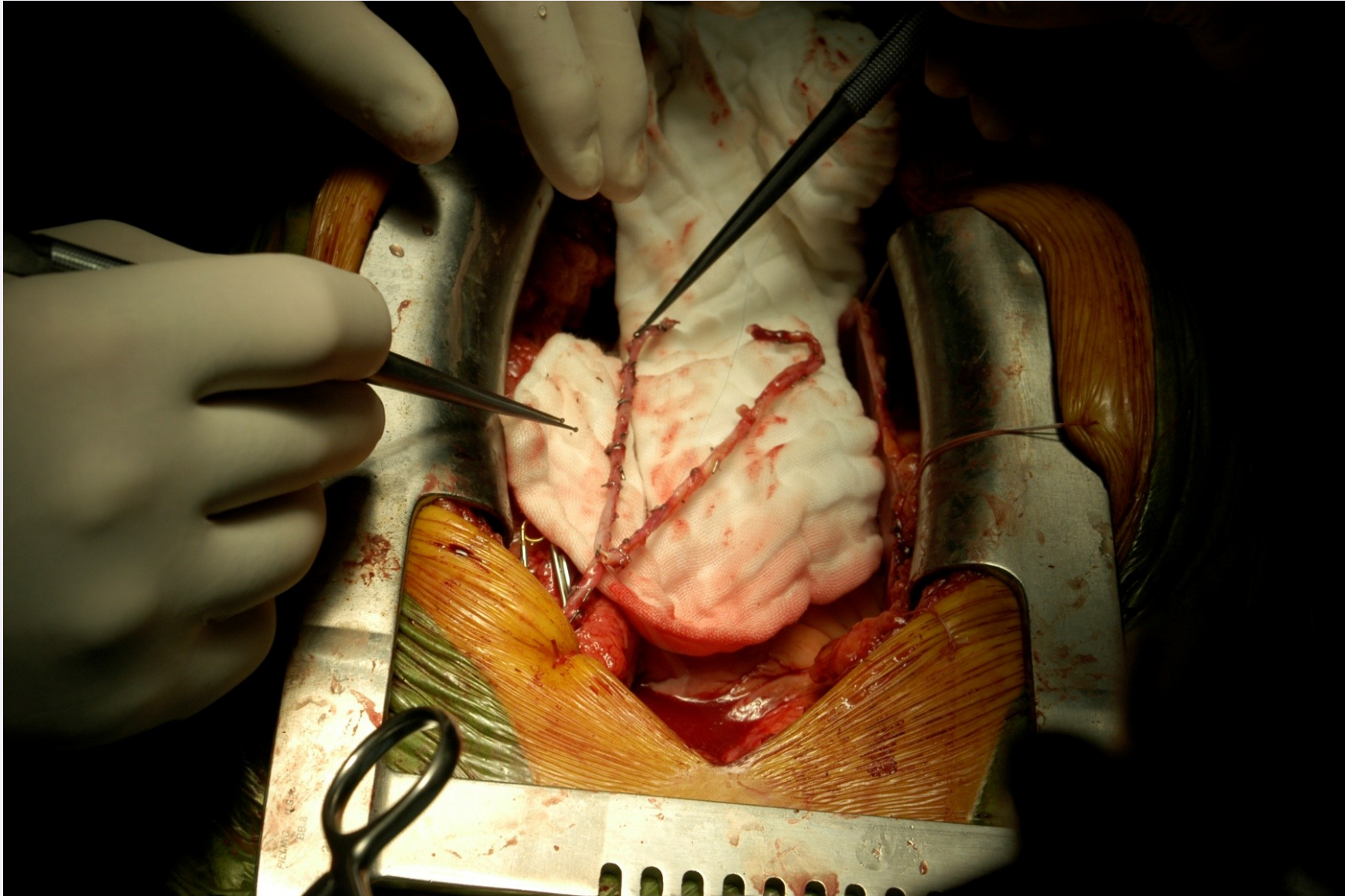
- great saphenous vein – 10 years patency 50-60%
- short saphenous vein
- brachial or cephalic veins from upper arms



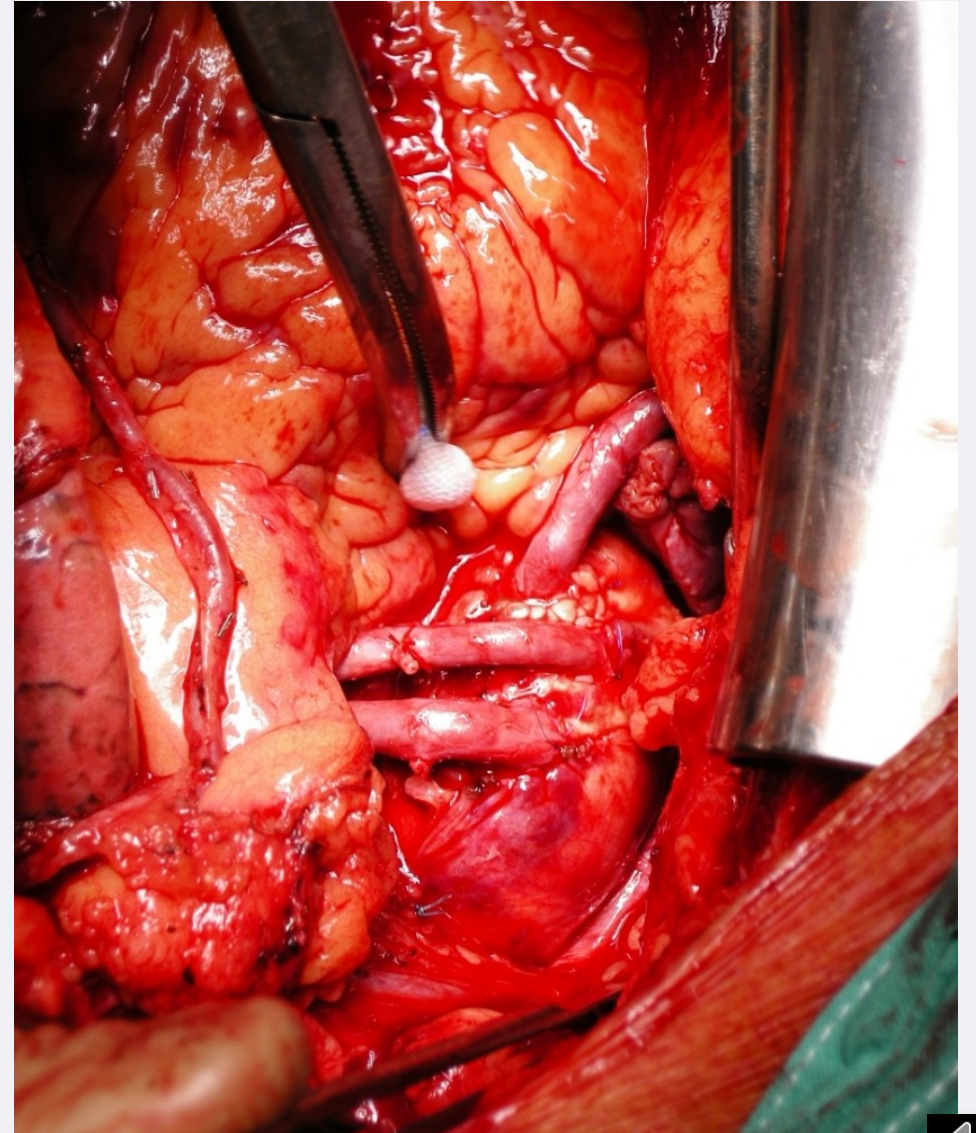
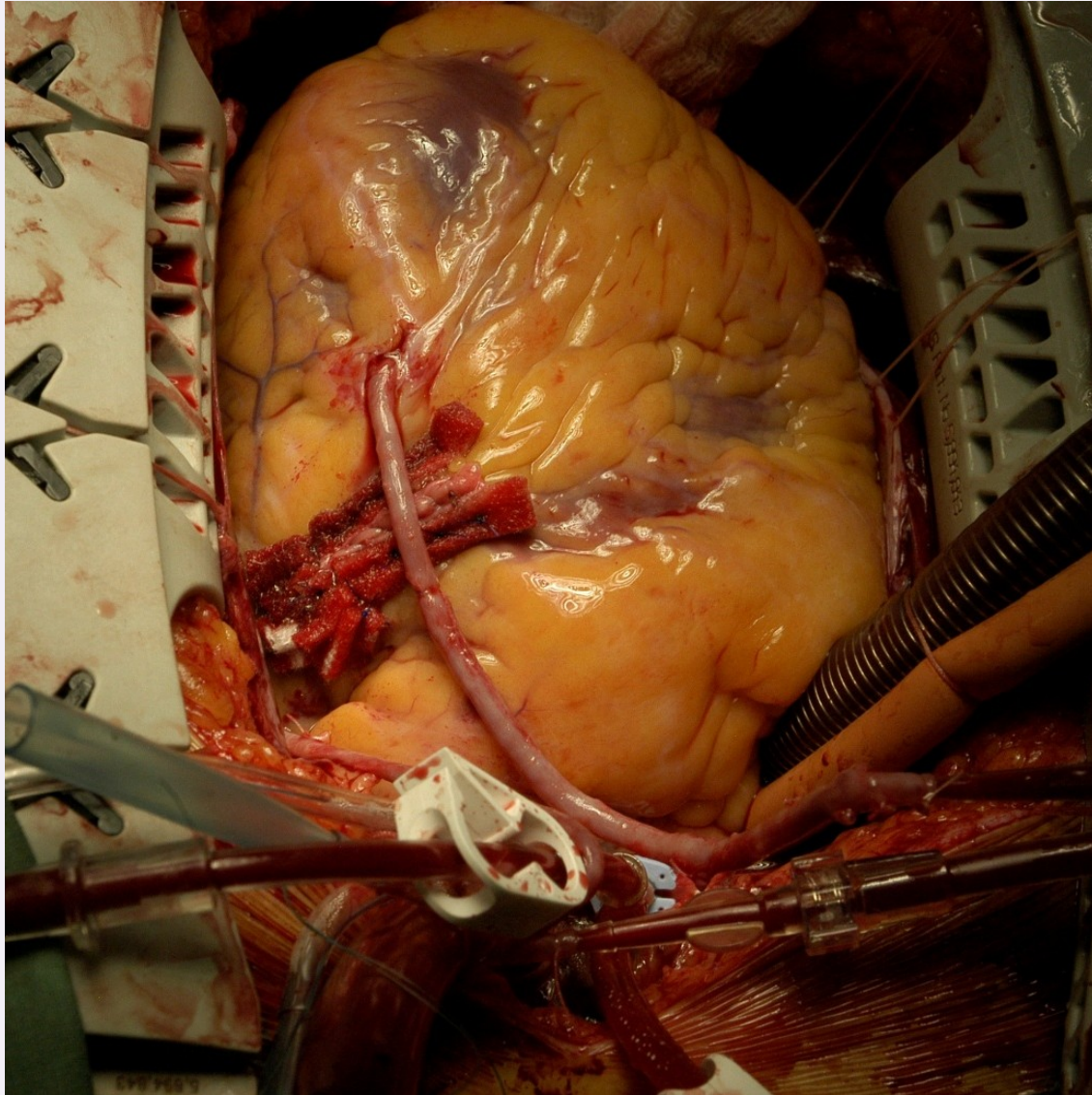
Endoscopic vein harvesting



Choice of conduits for coronary artery bypass



Choice of conduits for coronary artery bypass

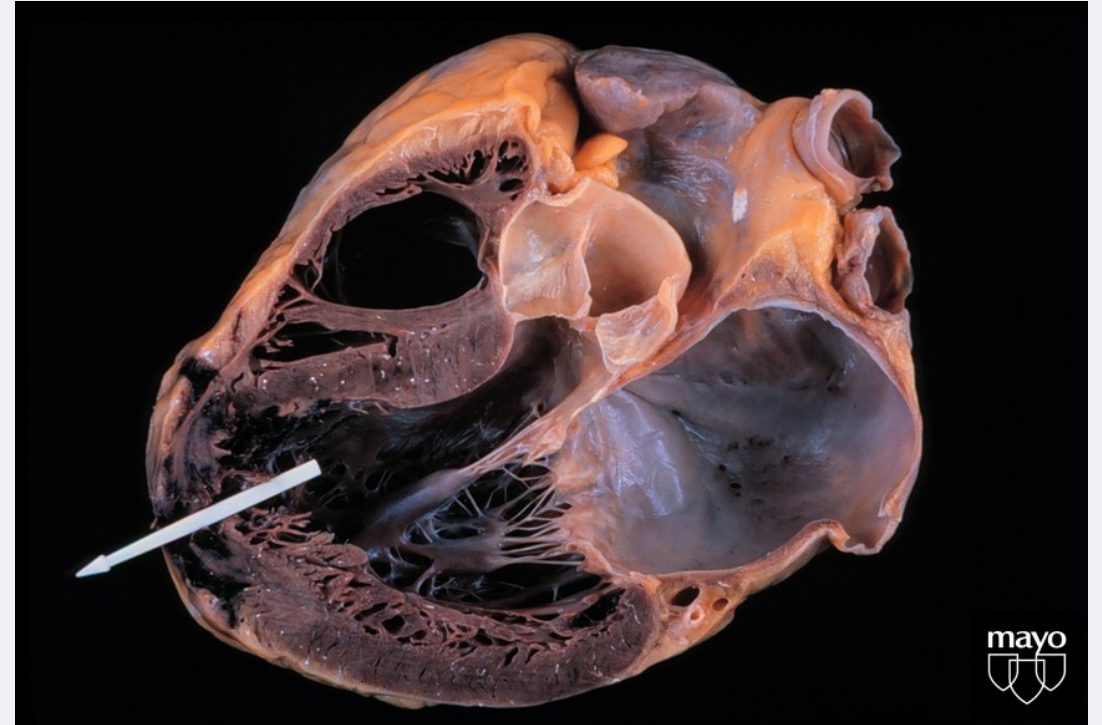
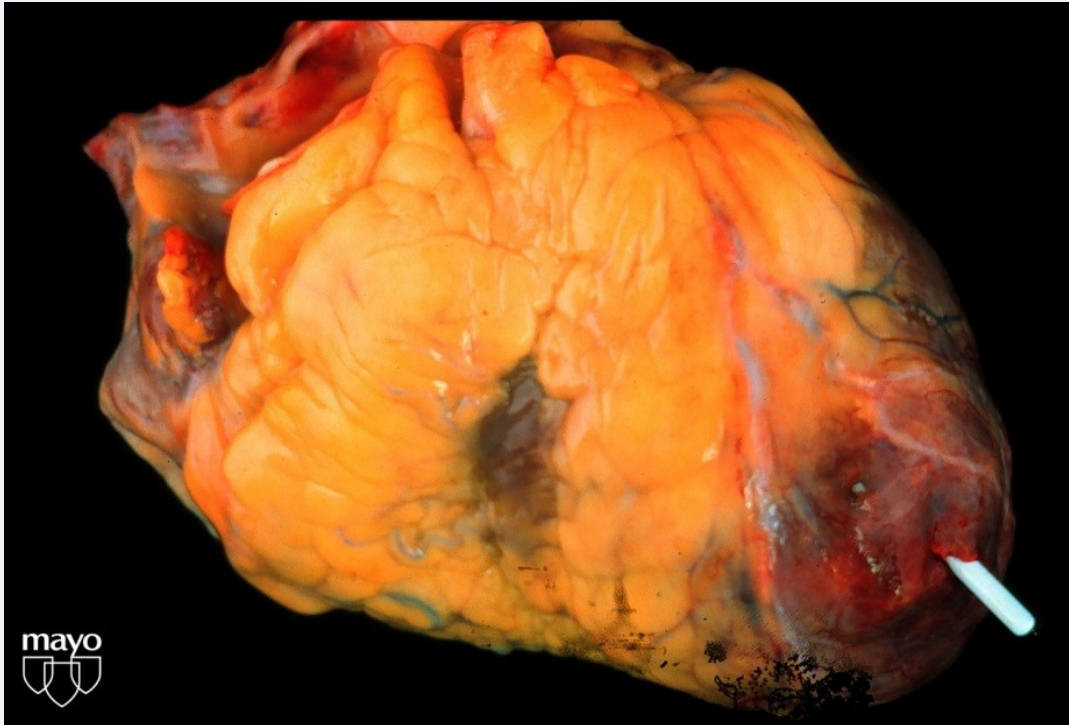


Mechanical complications of acute MI

free wall rupture

VSD

mitral regurgitation

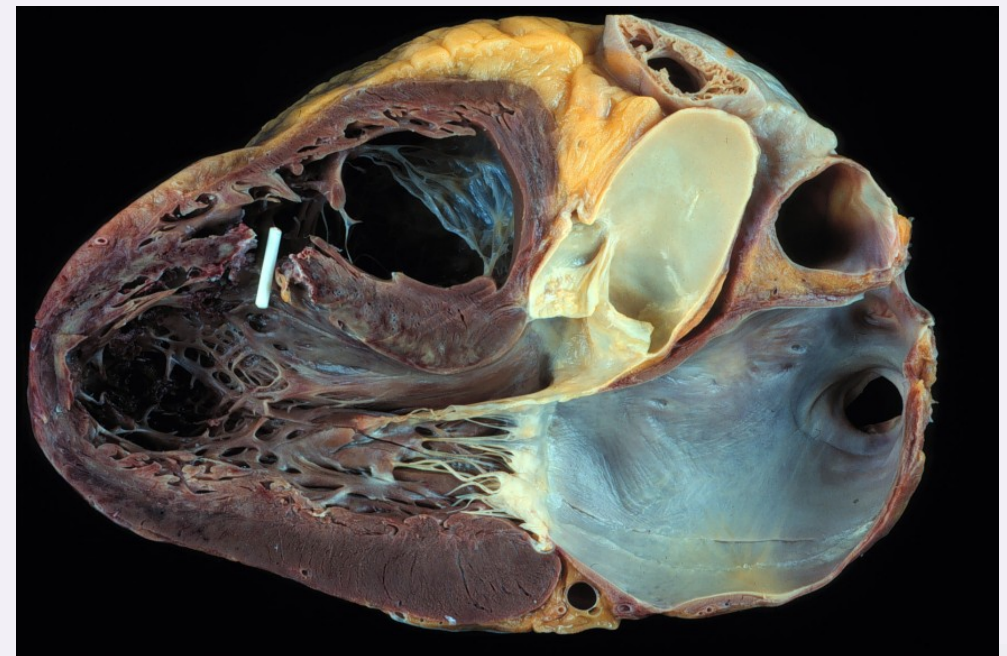
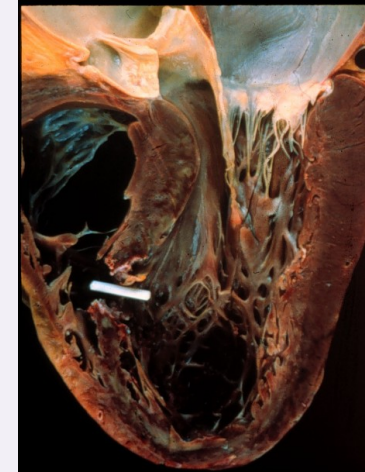


Mechanical complications of acute MI

free wall rupture

VSD

mitral regurgitation

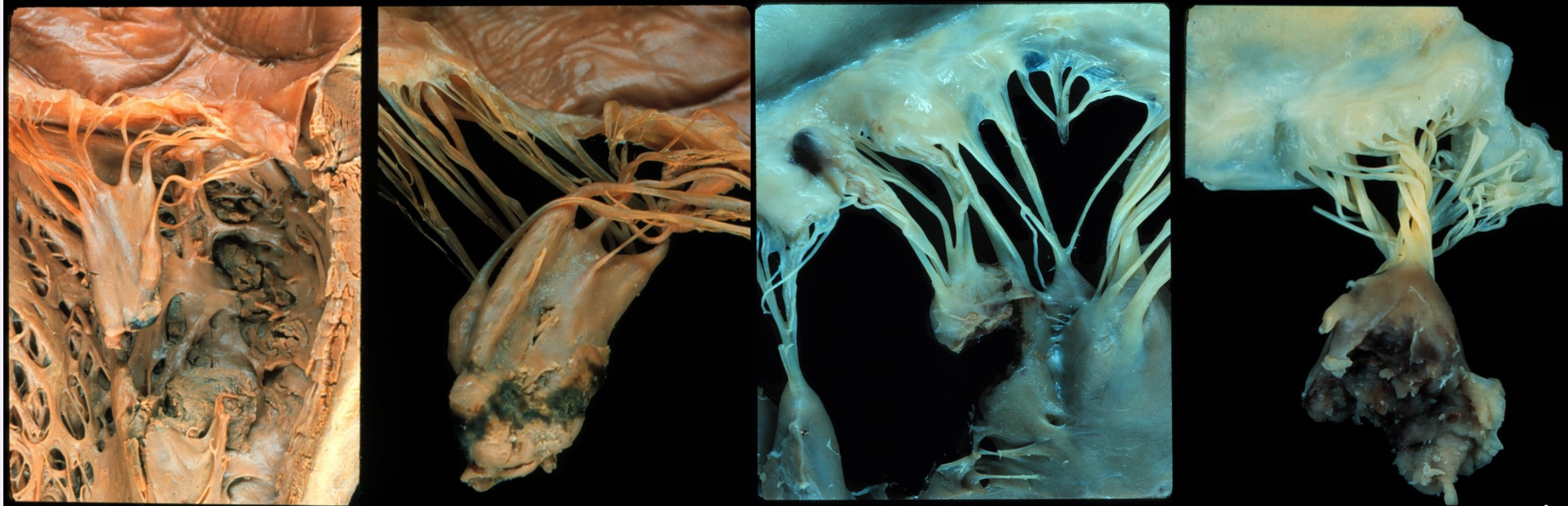


Mechanical complications of acute MI

free wall rupture

VSD

mitral regurgitation – papillary muscle rupture



Mechanical complications of acute MI

LV aneurysm

LV pseudoaneurysm

