Cardiac surgery – Introduction

László Hejjel MD, PhD
University of Pécs, Heart Institute
http://aok.pte.hu/en/egyseg/oktatasianyagok/290

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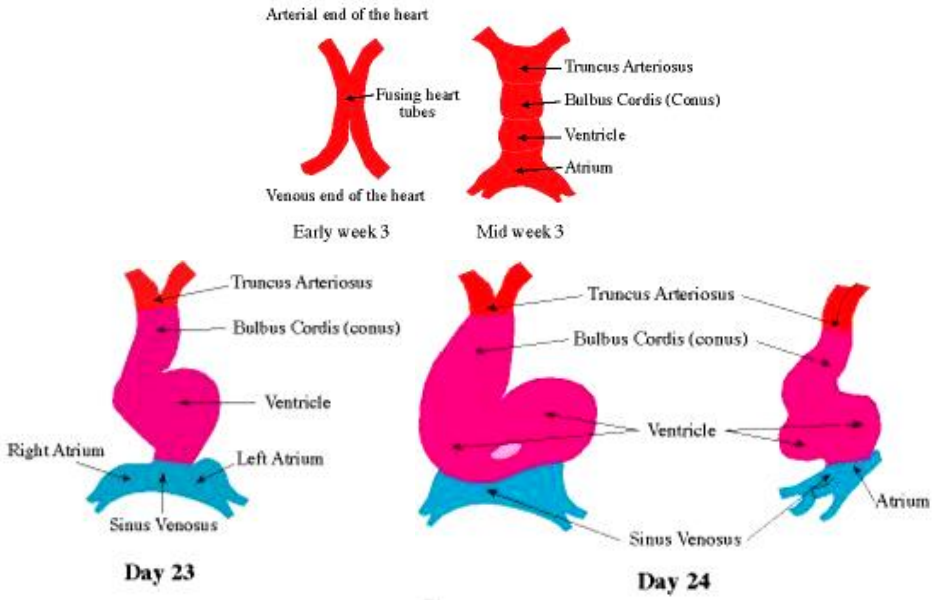
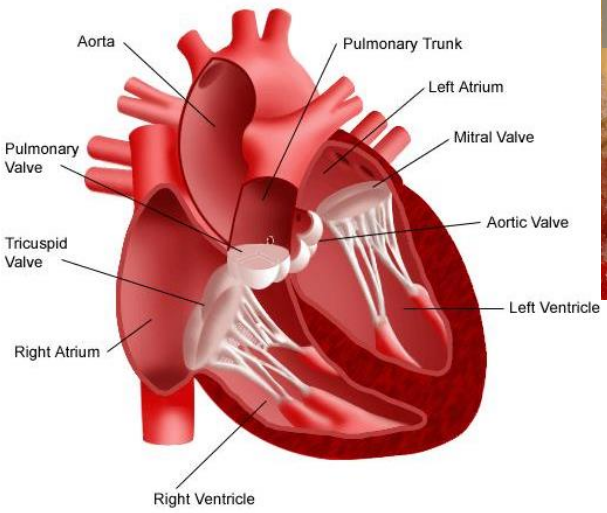
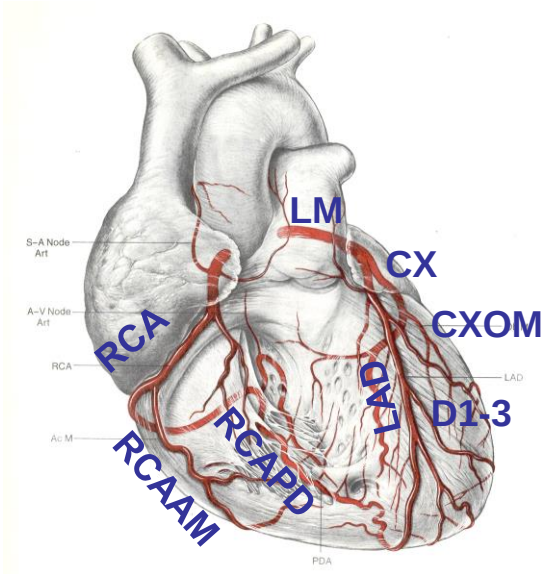
The development of the heart

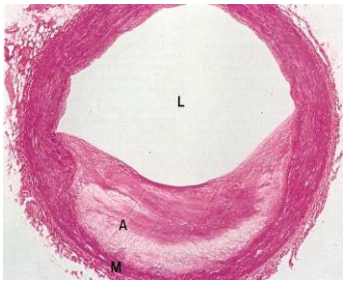


The anatomy of the heart



The anatomy of coronary arteries





Most common types of heart operations

- **coronary bypass grafting (CABG)**
- **valve replacement (AVR, MVR, TVR)**
- **valvuloplasty - repair (TVP, MVP, AVP)**
- **congenital (VSD, ASD, DBP…)**
- **operations on thoracic aorta (asc., arch)**
- **aneurysmectomy, aneurysm-plication**
- **heart transplantation and its alternatives**
- **pacemaker implantation**

combined operations (CABG+valve, CABG+ carotid endarterectomy, CABG+aneurysmectomy)

Milestones of cardiac surgery

Theodore Billroth (1821-1894): *'Any surgeon who would attempt operation on the heart should lose the respect of his colleagues'.*

Ludwig Wilhelm Carl Rehn (1849-1930)
First successful myocardial suture: **1896**

The requirements for modern cardiac surgery

- diagnostic background (coronarography, echo)
- asepsis, antibiotics
- transfusiology
- hemostaseology
- anesthesiology - intensive care
- extracorporal circulation
- myocardium protection
- operative technique
- artificial valves, other prostheses

Milestones in cardiac surgery

1896. Rehn (G, 1849-1930) successfully sutures a heart wound
1925. Souttar (UK, 1875-1964) – closed mitral commissurotomy
1928. Forssmann (G, 1904-1979) – first cardiac catheterization via cephalic vein on himself
1939. Gross (USA, 1905-1988) – ligature of ductus Botalli
1950-s Gibbon, Kirklin, Lillehei - ECC
1951. Vineberg a. thoracica interna implantation
Favaloro, Effler v. saphena bypass
1953. ASD operation
1955. VSD operation
1964. Kolesov a. thoracica interna-LAD bypass
1968. Green a. thoracica interna-LAD bypass

The making of the heart-lung machine

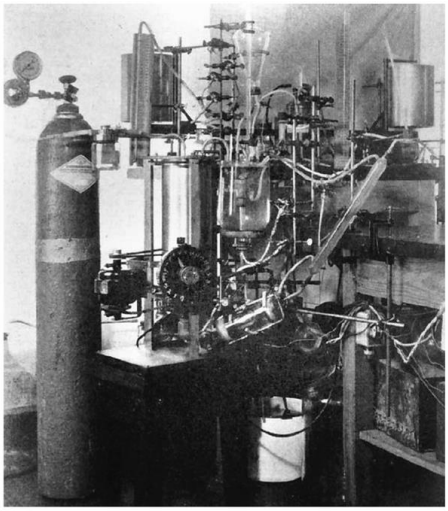
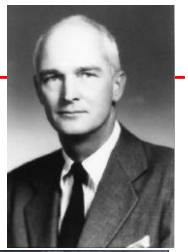


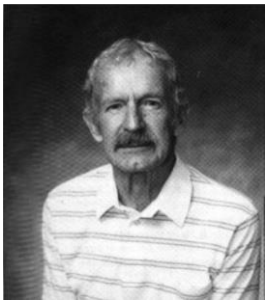
Fig 2. Photograph taken in Dr Gibbon's laboratory, showing an early version of his heart-lung machine. (Courtesy of J. H. Gibbon, Jr. Reprinted with permission from Gibbon JH et al. Arch Surg 1937; 34:1109.)



John Gibbon (1903-1973)

May 6th 1953. *The first successful ASD closure with the usage of heart lung machine (IBM).*

Hypothermia – other arm of the scale

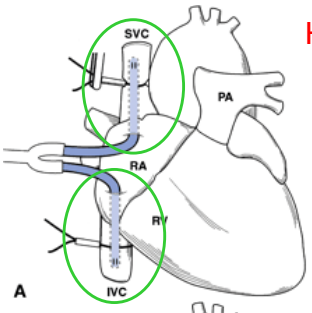


JF Lewis (1916-1993)

1953. *Lewis and Taufic: Closure of atrial septal defects with the aid of hypothermia. in Surgery*

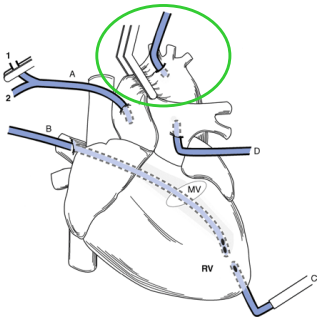
Sept. 2nd 1952. *The first open heart surgery, 2 cm ASD-II closure in a 5 year old girl, t=26°C full body hypothermia, with inflow stasis. (University of Minnesota Hospital)*

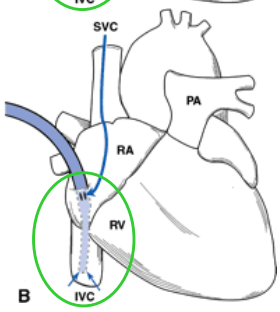
The schematic of extracorporeal circulation

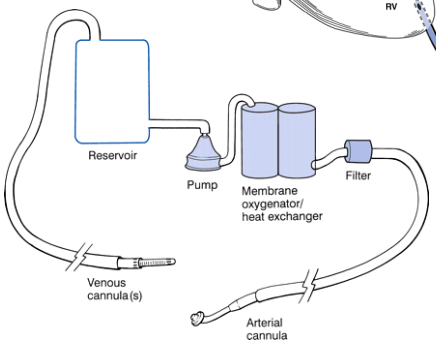


Heparinization:
300NE/bwkg
Na-heparin

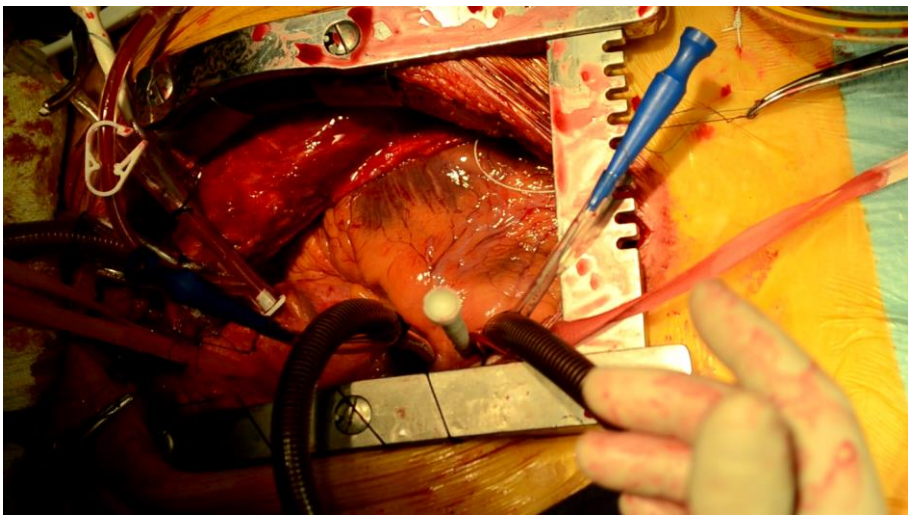
Antidote:
Protamin



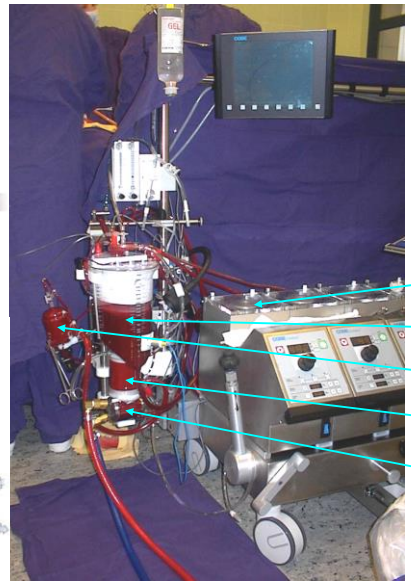


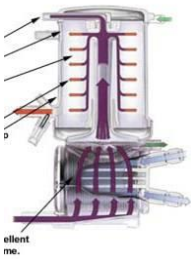


The cannulation in real life



A modern heart-lung machine





roller pump (2)

reservoir (1)

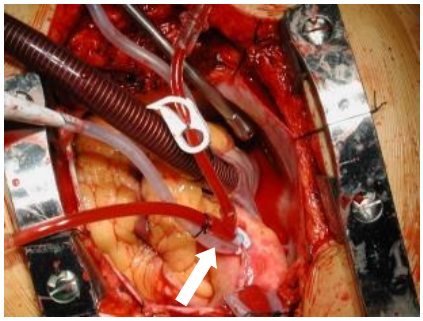
arterial filter(5)

oxygenator (3)

heater (4)

tubing set

Myocardial protection



anterograde aortic root cardioplegia and vent

local ice-squash

Myocardial protection by administering a special cold solution into the coronary circulation. **<u>The most popular:</u> +4 °C hyperkalaemic crystalloid cardioplegia, that causes depolarization block, arrest, sparing the energy expenditure of contraction and electric activity.**

The diagnosis of heart diseases

History: angina, dyspnea, fatigue

Physical changes: primarily not present in CAD, murmurs

Tests: ECG, stress ECG, Holter (silent ischaemia)

Echocardiography (TTE, TEE)

((Myocardium perfusion (heart light study): scintigraphy, SPECT))

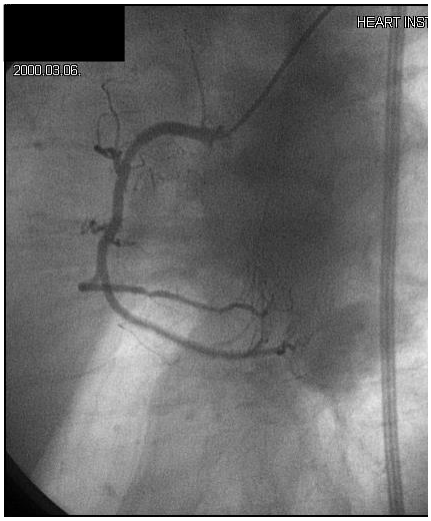
Coronary angio: above 40 years before any cardiac surgery
Coronary CT (or at suspicion of IHD)

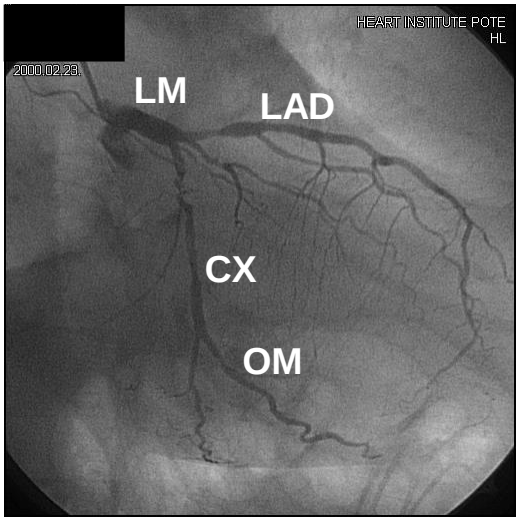
Viability examinations: MRI, (PET)
Biopsy

Preoperative examinations, preparation

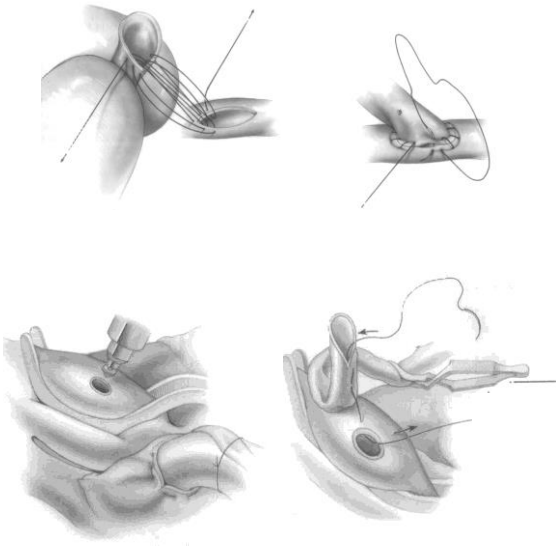
- investigating cardiac status, stabilizing patient
- above 40 years coronary angiography
- screening and treating foci (**dental**, ENT, urology/gynecology)
- chest X-ray, abdominal ultrasound
- carotid Doppler or carotid angiography
- respiratory function test
- specialist at any comorbidity or suspicion! (vascular surgeon, colonoscopy, gastroscopy, endocrinology, etc.)
- **discontinuing oral anticoag., anti-TCT, metformin**

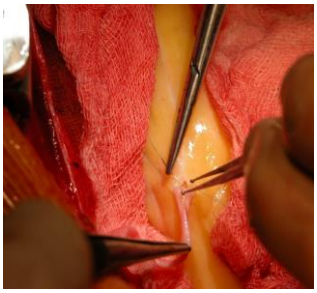
Coronary angiography

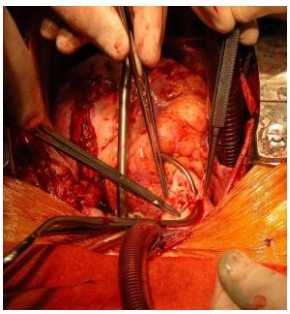




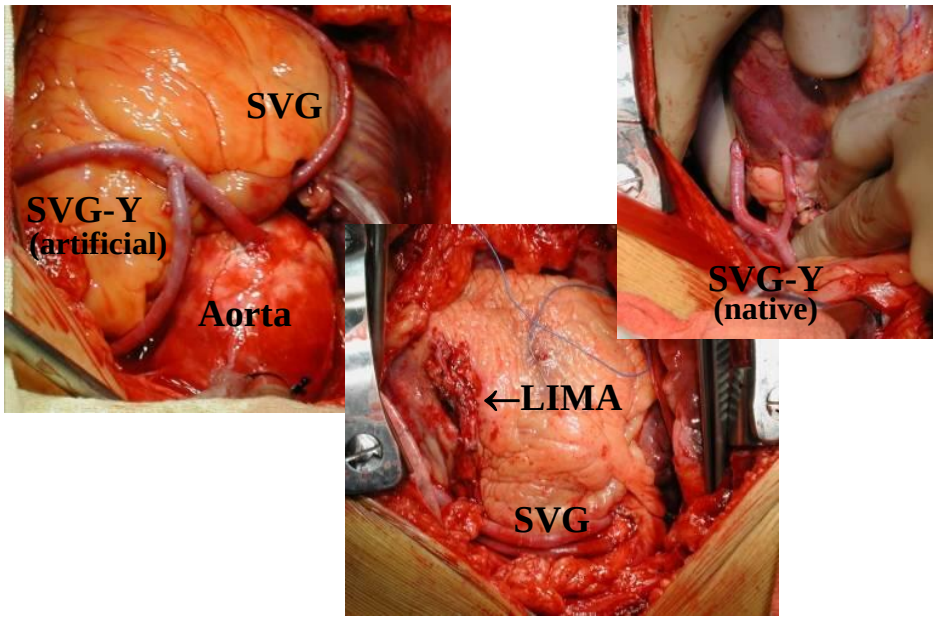
Surgical technique: distal and proximal anastomosis







Coronary surgery: before the pericardium closure



Follow-up for CABG

Before discharge screening for ASA efficiency by thrombocyte aggregometry (TAG), adding clopidogrel if necessary, LMWH

Cardiac surgery control at 6-8 weeks: complaints, wound heeling, sternum stability, ECG, Echocardiography

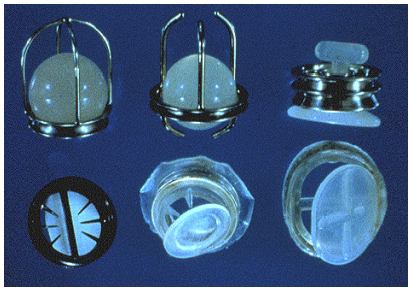
Cardiology control every 6 months or annually (ECG, stress test, Echocardiography), on demand interventional or cardiac surgical control, see family physician

Anti-platelet drugs life-long, if should be stopped before any intervention → administer LMWH

Secondary prevention: lifestyle, diet, drugs (statin, anti-TCT, β-blocker, etc.)

Milestones of valvular surgery

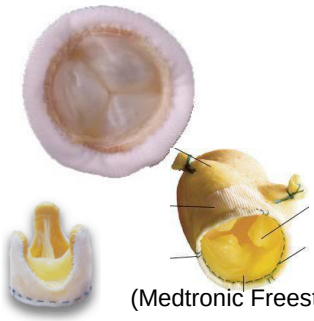
Commissurotom, Souttar, 1925.



Opening angle of modern valves assures minimal flow resistance

Modern arteficial heart valves

biograft



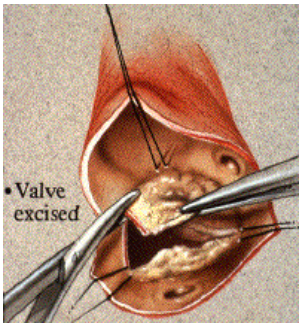
(Medtronic Freestyle)

Toronto SPV stentless

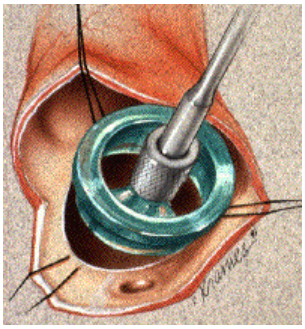
bileaflet

tilting disc

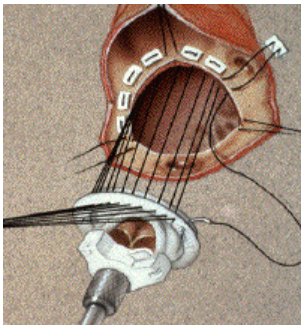
Valve implantation technique



Excising diseased valve

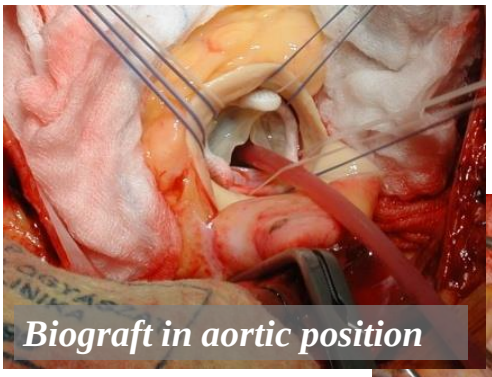


Measurement

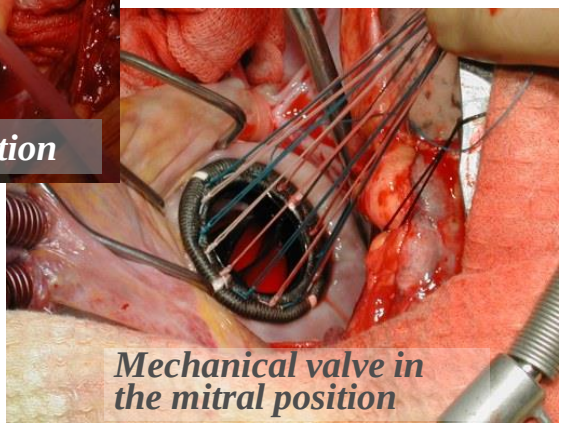


Suturing arteficial valve

Intraoperative views



Biograft in aortic position



Mechanical valve in the mitral position

Patient follow-up after valve op.

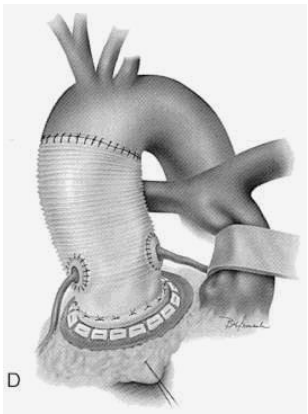
Anticoagulation: **Syncumar/Cumadine to INR**
Biograft: 3-6 months (INR 2.0-3.0), then ASA
Mechanical: life-long (Ao: 2.0-3.0, M: 2.5-3.5)
Tell it before any medical intervention !
1 week before any operation change to LMWH
postoperatively LMWH for some days

Endocarditis profilaxis: **antibiotics (any implant)**
In case of dental extraction (depuration) or before and after any invasive intervention
(amoxicillin, clindamycin, iv.: ampicillin, vanco, genta)

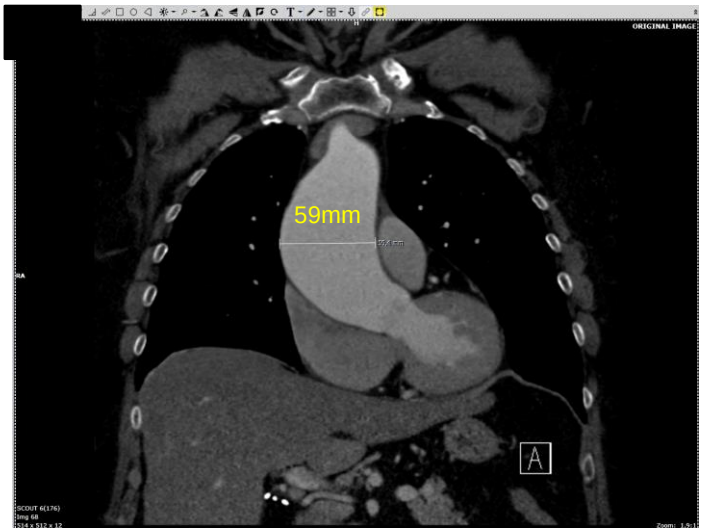
Bentall-operation (valve+graft)

Conduit

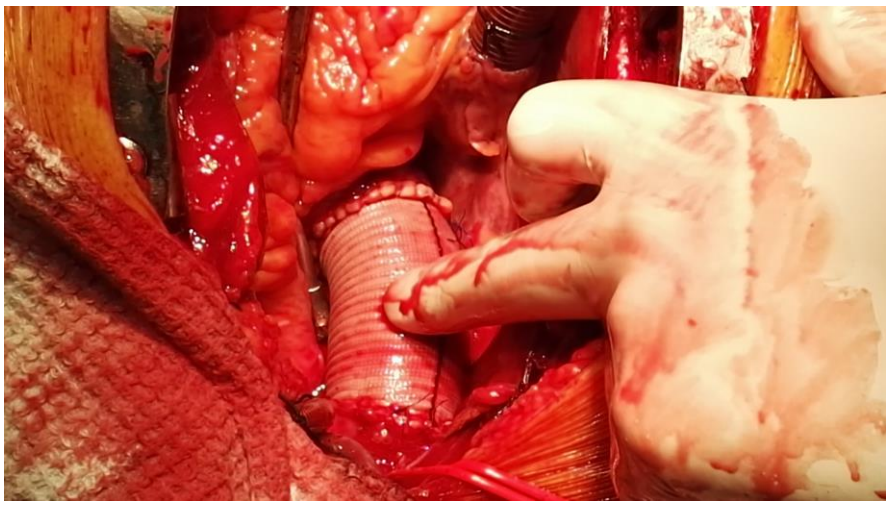
Valved conduit in situ



Aortic aneurysm, ECG-gated angio CT



Interpositum after AAA



Classification of congenital heart diseases

Left-to-right shunt
- atrial septal defect
- ventricular septal defect
- persistent ductus arteriosus
- atrioventricular septal deffect
- partial transposition of pulmonary veins

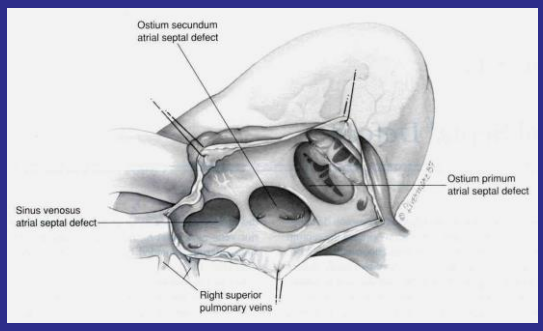
Obstructive
- aorta stenosis
- pulmonary stenosis
- coarctation of aorta

Cyanotic (right-to-left shunt)
- great vessel transposition
- tetralogy of Fallot
- tricuspidal atresia
- pulmonary atresia
- Ebstein-anomaly
- total transposition of pulmonary veins
- persistent truncus arteriosus
- univentricular heart

Operative management

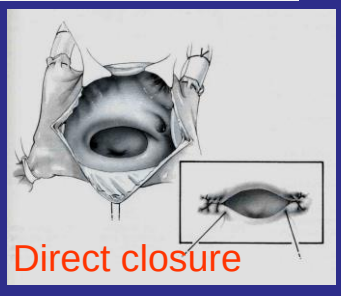
- Why operate? symptoms of circulatory failure, frequent airway infections, retardation in growth, Eisenmenger syndrome
- Earlier: several-stage operations starting with palliation
- Nowadays primary total anatomical reconstruction even in newborns
- Reduced mortality recently
- Less demanding for the society and for the family
- Diagnostics: mainly echocardiography, less angiocardiography (X-ray, contrast agent!), cardiac MRI

Atrial septal defect (ASD)

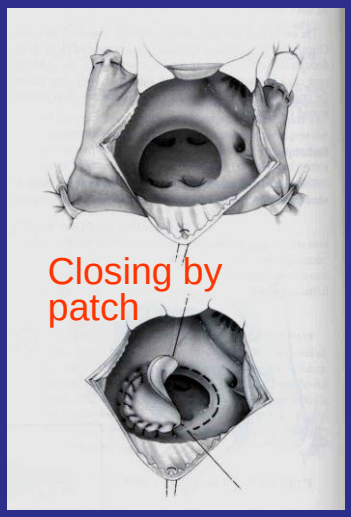


Op.:
Qp/Qs > 2.0

Paradoxic emb.



Direct closure



Closing by patch

Heart transplantation (HTX)

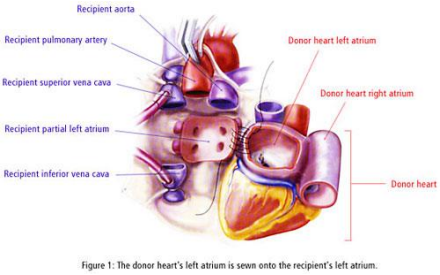
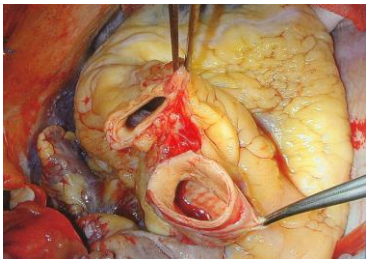
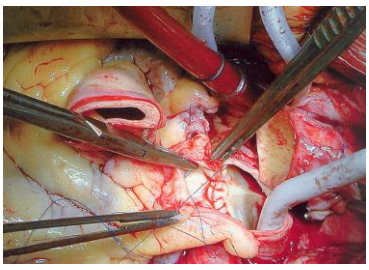


Figure 1: The donor heart's left atrium is sewn onto the recipient's left atrium.



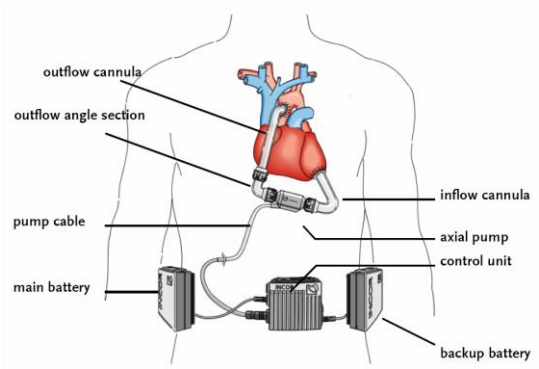


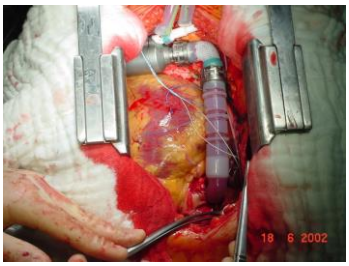
Mechanical circulatory assist: Berlin Heart Incor

INR: 2,8-3,2

APTI: 70-90 s

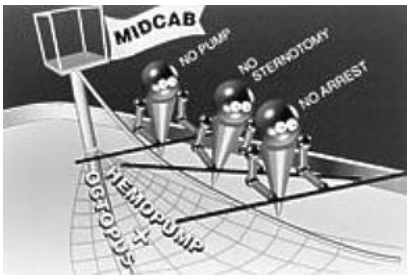
Efficient anti-TCT



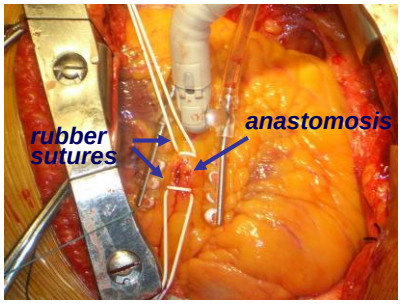


Coronary surgery: minimally invasive directions

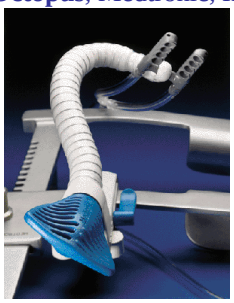
„off-pump" CABG
MIDCAB

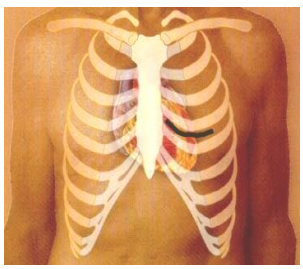


Stabilizing LAD



Octopus, Medtronic, Inc.

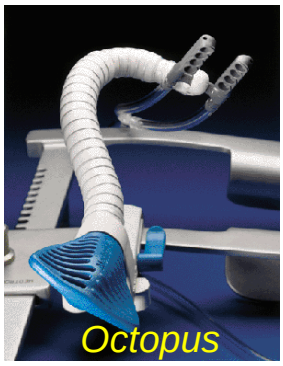




Off-pump CABG operation

- avoids side-effects of ECC
- risk of hypoperfusion↑
- clamping ascending aorta

- special instrumentation
- occluder or shunt occluder
- difficult access to posterior vessels
- cannot open heart chamber
- operative manipulation affects cardiac outpt

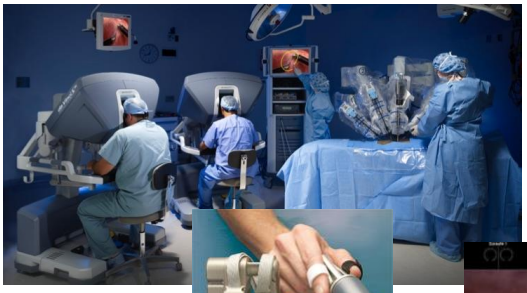


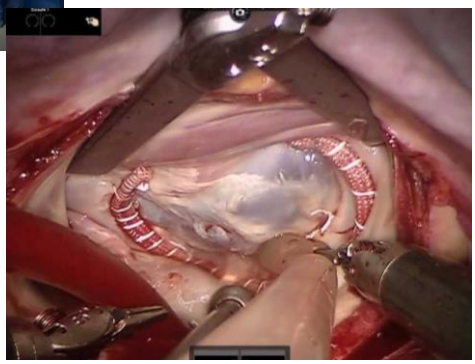
Minimally invasive access

- smaller (even 4-6 cm!) incision
- minimal tissue damage, intact chest wall

- Less operative stress
- Shorter operation (?)
- Less complications (?)
- Less pain
- Faster recovery
- Early rehab
- Better cosmetic results
- Reduced costs (?)

Robot-assisted heart surgery





- Mitral plasty
- CABG
- PM electrode implant.
- Etc.

Endocarditis risk in different populations

- High risk:
  - previous infective endocarditis
  - artificial valve, TAVI, foreign material
  - congenital heart disease (exc. valvular)
  - ventricular assist device

- Intermediate risk:
  - rheumatic heart disease
  - degenerative valve disease
  - congenital heart disease (incl. Bicuspidal av.)
  - cardiovascular implanted electronic devices
  - hypertrophic cadiomyopathy

Recommendations for infective endocarditis prevention in high-risk patients

Recommendations	Class	Level
Antibiotic prophylaxis is recommended in dental extractions, oral surgery procedures, and procedures requiring manipulation of the gingival or periapical region of the teeth.	I	B
Systemic antibiotic prophylaxis may be considered for high-risk patients undergoing an invasive diagnostic or therapeutic procedure of the respiratory, gastrointestinal, genitourinary tract, skin, or musculoskeletal systems.	IIb	C

2023 ESC Guidelines for the management of endocarditis
(European Heart Journal; 2023 – doi: 10.1093/eurheartj/ehad193)

Recommendations for antibiotic prophylaxis in patients with cardiovascular diseases undergoing oro-dental procedures at increased risk for IE (1)

Recommendations	Class	Level
General prevention measures are recommended in individuals at high and intermediate risk for IE.	I	C
Antibiotic prophylaxis is recommended in patients with previous IE.	I	B
Antibiotic prophylaxis is recommended in patients with surgically implanted prosthetic valves and with any material used for surgical cardiac valve repair.	I	C
Antibiotic prophylaxis is recommended in patients with transcatheter implanted aortic and pulmonary valvular prostheses.	I	C
Antibiotic prophylaxis is recommended in patients with untreated cyanotic CHD, and patients treated with surgery or transcatheter procedures with post-operative palliative shunts, conduits, or other prostheses. After surgical repair, in the absence of residual defects or valve prostheses, antibiotic prophylaxis is recommended only for the first 6 months after the procedure.	I	C

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Recommendations for antibiotic prophylaxis in patients with cardiovascular diseases undergoing oro-dental procedures at increased risk for IE (2)

Recommendations	Class	Level
Antibiotic prophylaxis is recommended in patients with ventricular assist devices.	I	C
Antibiotic prophylaxis should be considered in patients with transcatheter mitral and tricuspid valve repair.	IIa	C
Antibiotic prophylaxis may be considered in recipients of heart transplant.	IIb	C
Antibiotic prophylaxis is not recommended in other patients at low risk for IE.	III	C

Prophylactic antibiotic regime for high-risk dental procedures

Situation	Antibiotic	Single-dose 30–60 min before procedure	
		Adults	Children
No allergy to penicillin or ampicillin	Amoxicillin	2 g orally	50 mg/kg orally
	Ampicillin	2 g i.m. or i.v.	50 mg/kg i.v. or i.m.
	Cefazolin or ceftriaxone	1 g i.m. or i.v.	50 mg/kg i.v. or i.m.
Allergy to penicillin or ampicillin	Cephalexin	2 g orally	50 mg/kg orally
	Azithromycin or clarithromycin	500 mg orally	15 mg/kg orally
	Doxycycline	100 mg orally	<45 kg, 2.2 mg/kg orally >45 kg, 100 mg orally
	Cefazolin or ceftriaxone	1 g i.m. or i.v.	50 mg/kg i.v. or i.m.

Thank you for your attention !