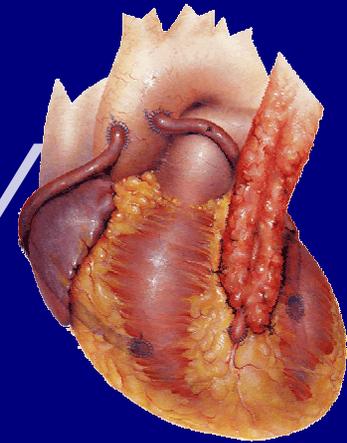
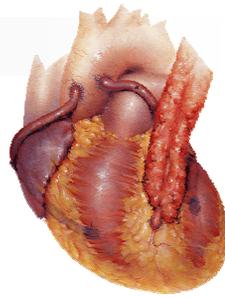


Cardiac Surgery

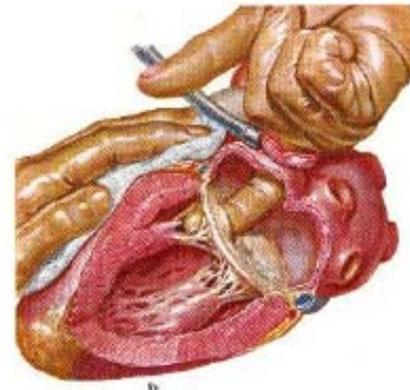


Nakorn Boonme

History



- **First successful heart operation: Rehn, 1896**
Successful suture of an heart wound
- **Congenital cardiac surgery**
 - Ductus arteriosus: Gross, 1938
 - Coarctation of the aorta: Crafoord, 1944
 - Blalock-Taussig operation: 1944
- **Mitral valvulotomy: Bailey, 1948**
(first case: Souttar, 1925)



History



- **Indirect revascularization of the heart: Beck, 1930**
collateral blood flow to ischemic myocardium
- **First cases direct coronary artery surgery: 1960 – 64**
operations performed on a beating heart
- **First large series of Coronary Artery Bypass Graft patients: Favaloro, Green, 1968**



History

The heart needs to be stopped to repair intracardiac lesions or to improve coronary surgery

- **Cardiac arrest:** irreversible brain damage occurs if circulatory arrest lasts over **3 minutes** in normothermia
- **Two solutions:**
 - 1) **Hypothermia:** increases the duration of safe cardiocirculatory arrest by decreasing the oxygen consumption
 - 2) **Heart lung machine:** replaces the cardiopulmonary function

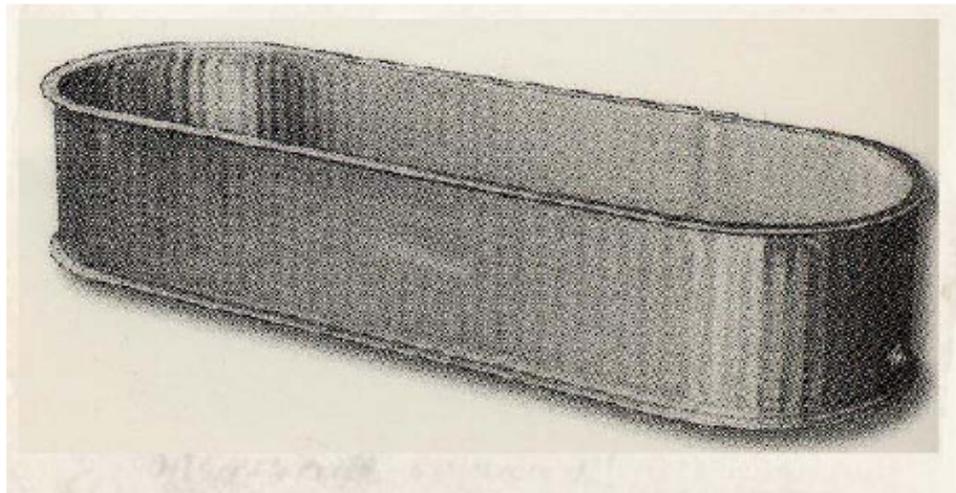
History



- **Hypothermic technique, surface cooling: Lewis, 1952**

Closure of an atrial septal defect in a 5-year-old girl

(five and one-half minutes at 28°C)



History



- **Heart lung machine: Gibbon, 1953**

*Closure of an atrial septal defect
in an 18-year-old girl*



By the end of 1956, many programs were launched into open heart surgery around the world

*Currently, **more than one million operations** are performed each year under extracorporeal circulation, worldwide*

- **Resurgence of beating heart surgery: Benetti, 1991**
- **First robotic operation of the heart: Carpentier, 1998**

History

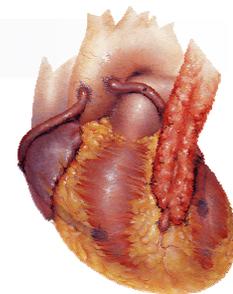


Many developments and inventions have been involved in this course:

- Mechanical ventilation
- Defibrillator
- Transfusion
- Heparin
- Antibiotics
- Cardioplegia
- Selective coronary angiography: Sones, 1962
- ...

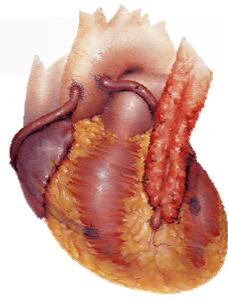


Surgical approaches for heart exposure



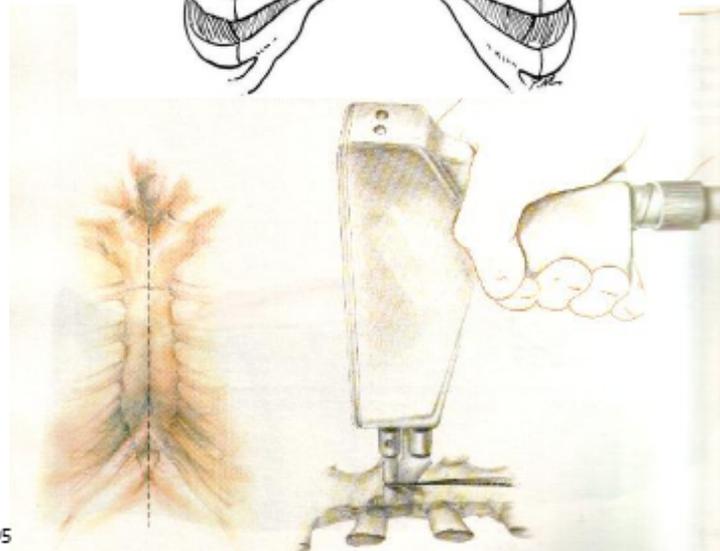
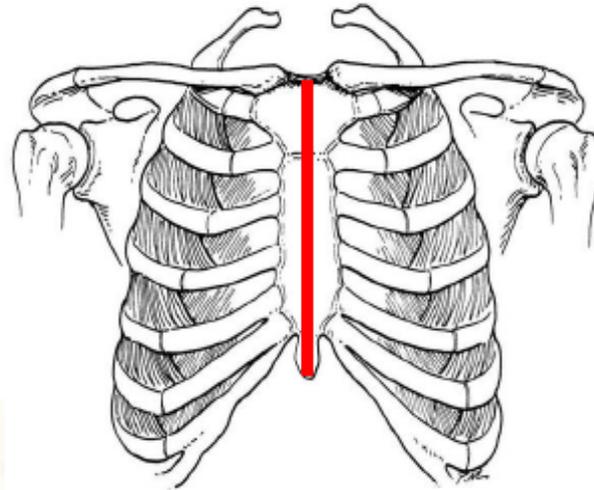
Surgical approaches for heart exposure

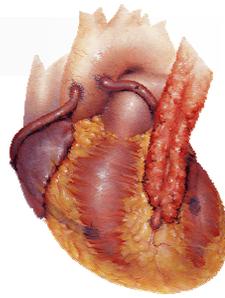
- **Sternotomy**
- **Thoracotomy**
- **Minimally invasive cardiac surgery**



Sternotomy

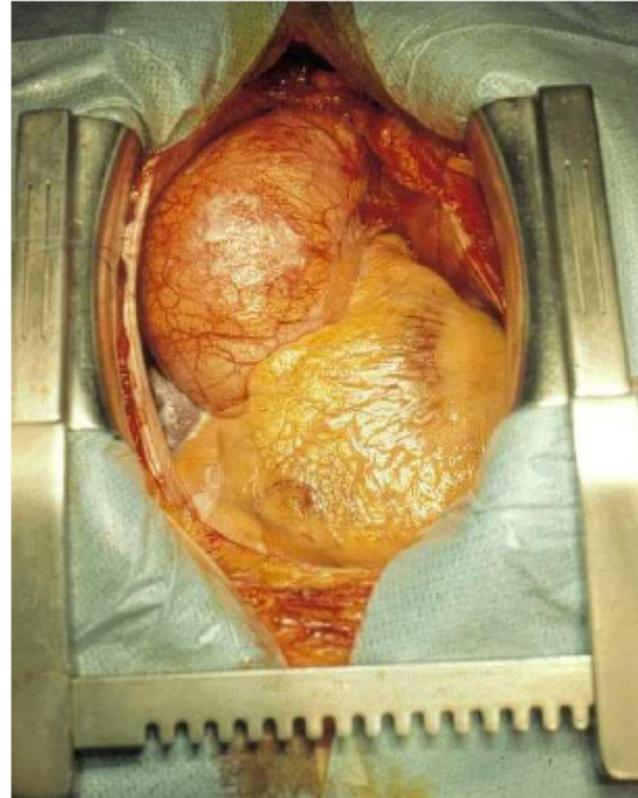
- Sternotomy approach
 - allows almost all cardiac procedures
 - best overall access to the heart
- The sternum is divided with a saw





Sternotomy

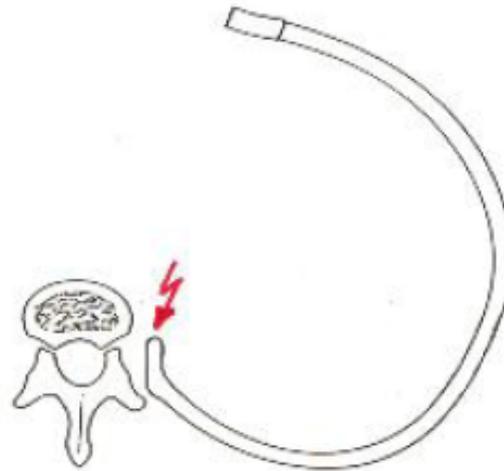
- A retractor is placed
- The pericardium is incised and sutured to the wound towel, elevating the heart for better exposure

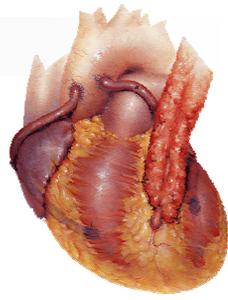


Sternotomy



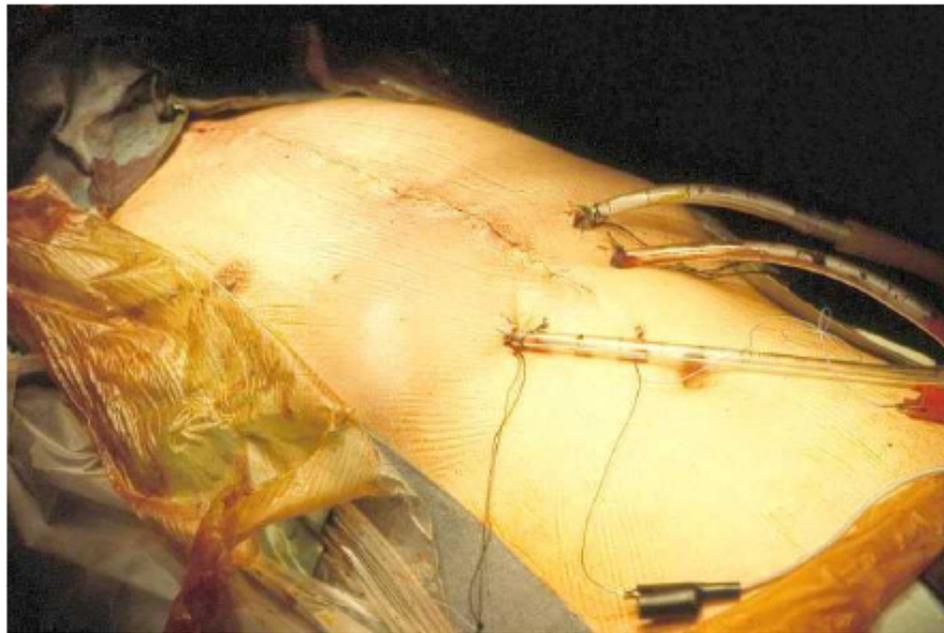
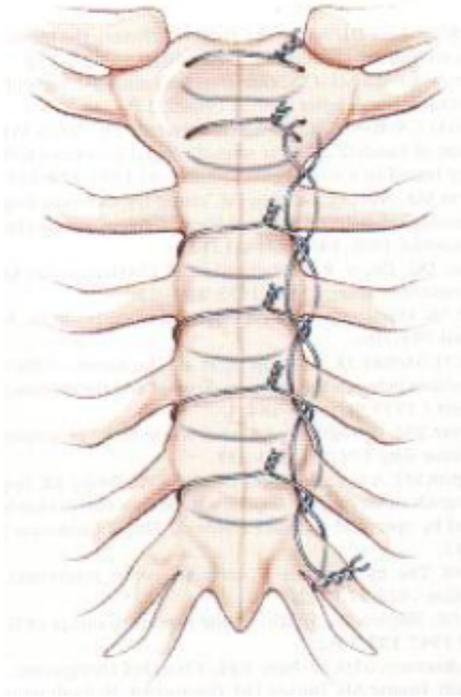
Expansion of the retractor is responsible for chest pain and can cause rib fractures



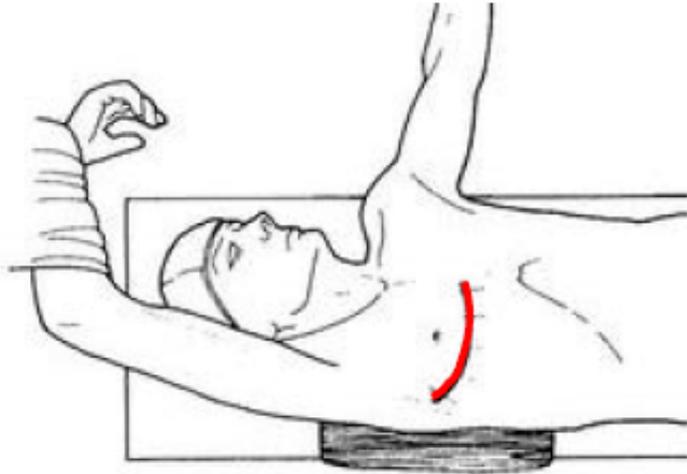


Sternotomy

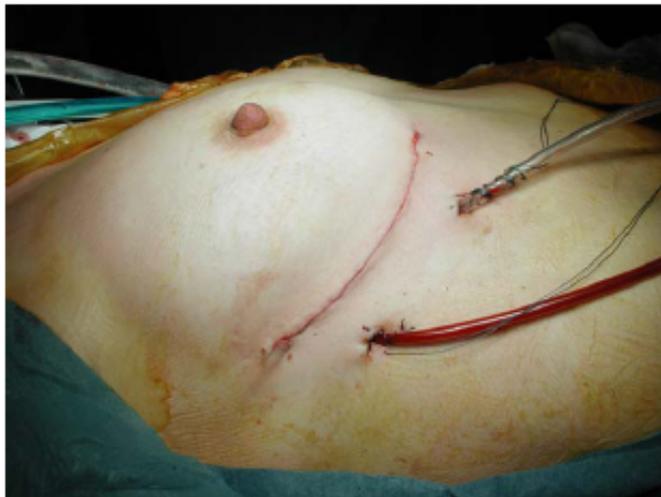
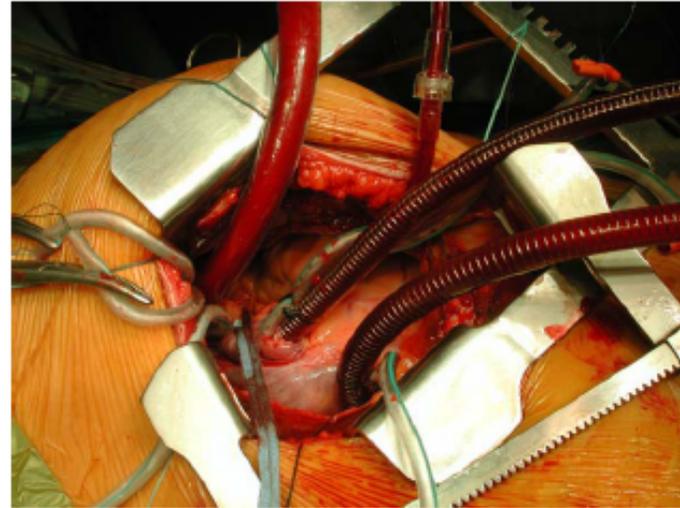
- Closure

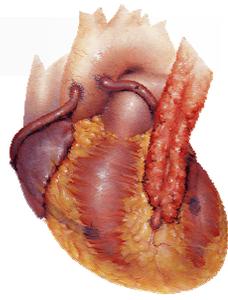


Right anterolateral thoracotomy

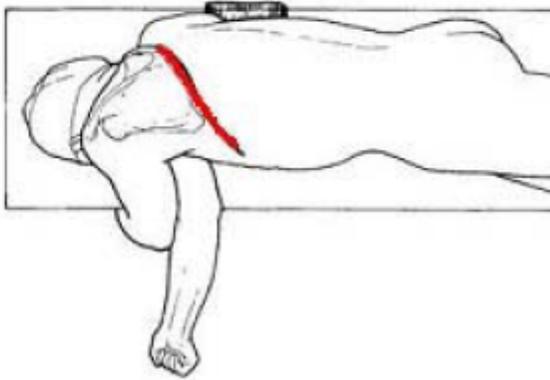


Adapted from: Les thoracotomies, M Noirclerc et al, in Traité de Techniques chirurgicales - Thorax : 42-205, Encycl Méd Chir , Elsevier, Paris, 1986

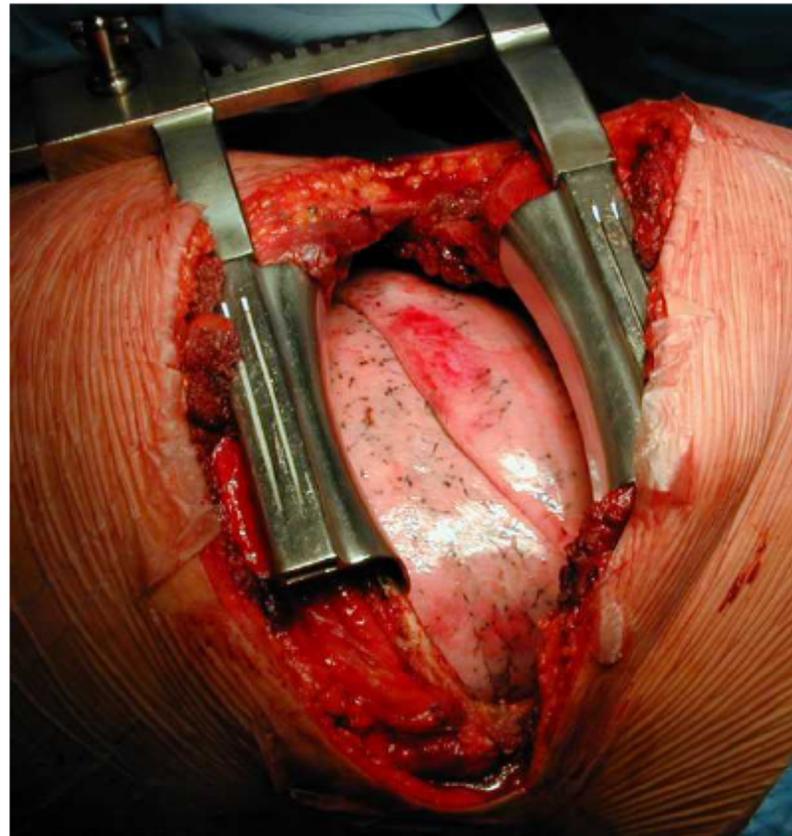




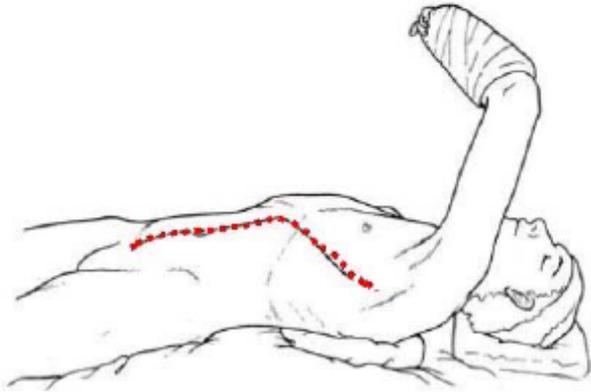
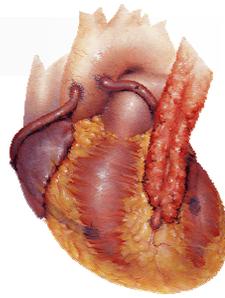
Left posterolateral thoracotomy



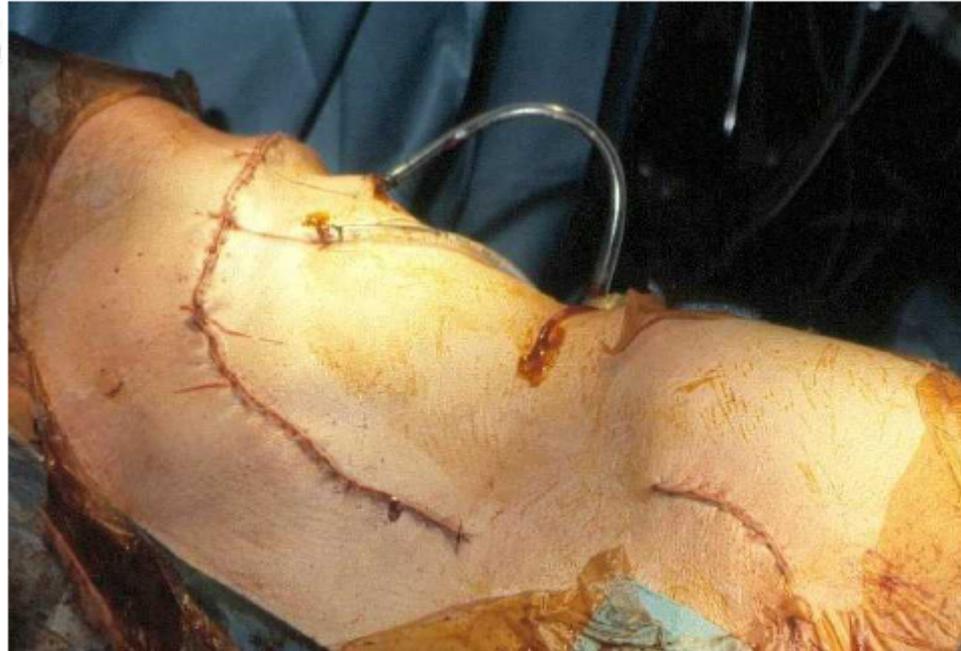
Adapted from: Les thoracotomies, de Rouquier et al, in Atlas de techniques chirurgicales - Thorax : 42-205, Encycl Méd Chir , Elsevier, Paris, 1986

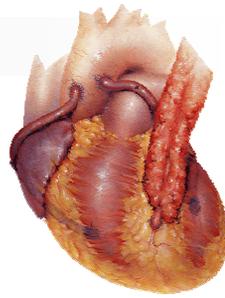


Thoracoabdominal incision

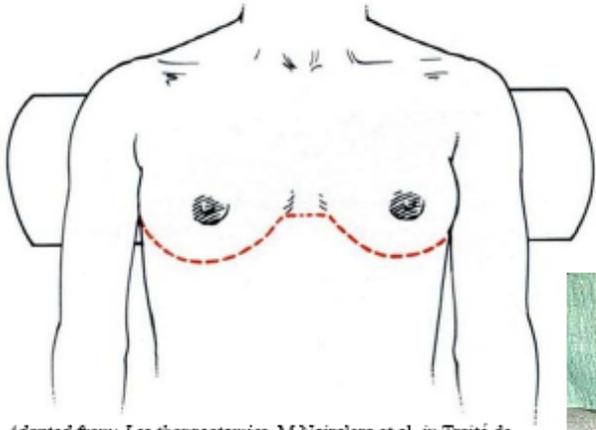


Adapted from: Les thoracotomies, M Noirclerc et al, in Traité de Techniques chirurgicales - Thorax : 42-205, Encycl Méd Chir , Elsevier, Paris, 1986

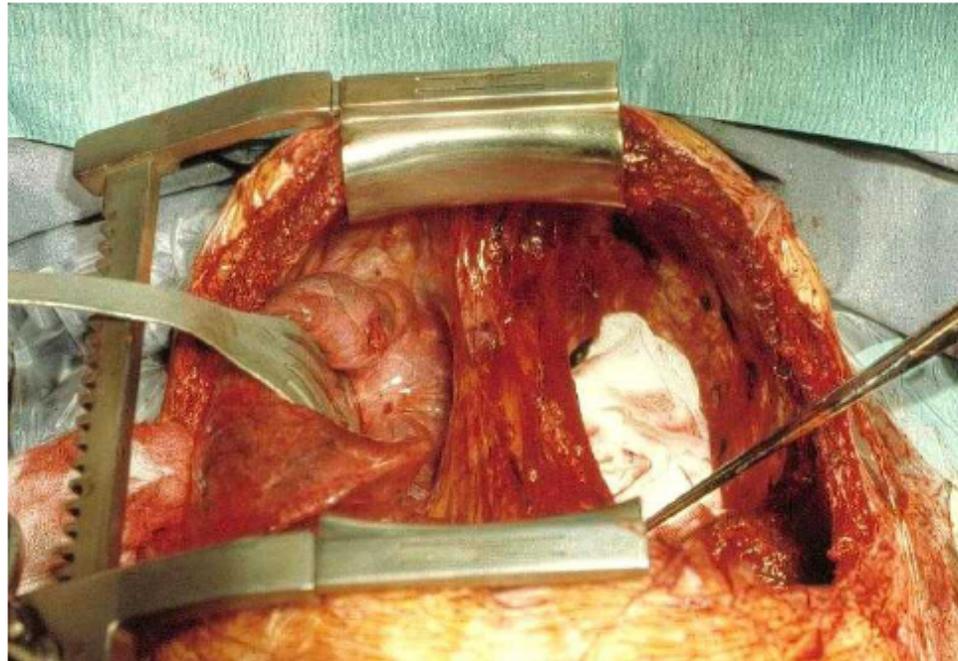




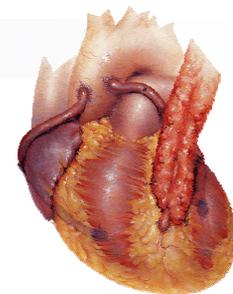
The bilateral transverse thoracosternotomy (clam shell incision)



Adapted from: Les thoracotomies, M Noirclerc et al, in Traité de Techniques chirurgicales - Thorax : 42-205, Encycl Méd Chir , Elsevier, Paris, 1986

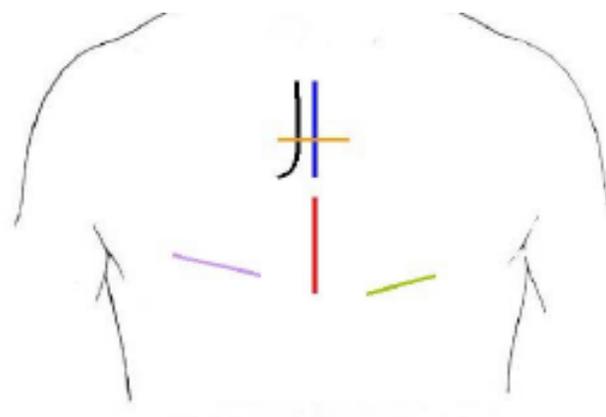


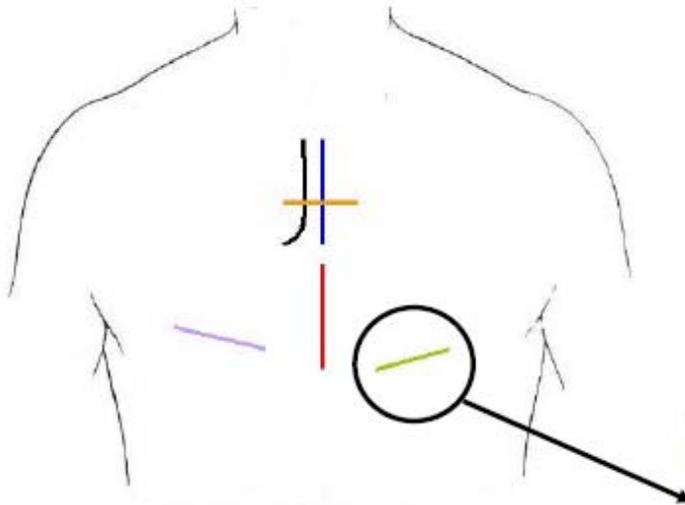
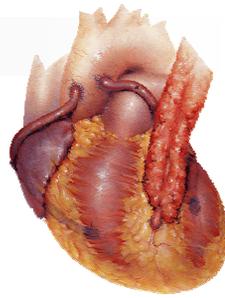
Minimally invasive cardiac surgery



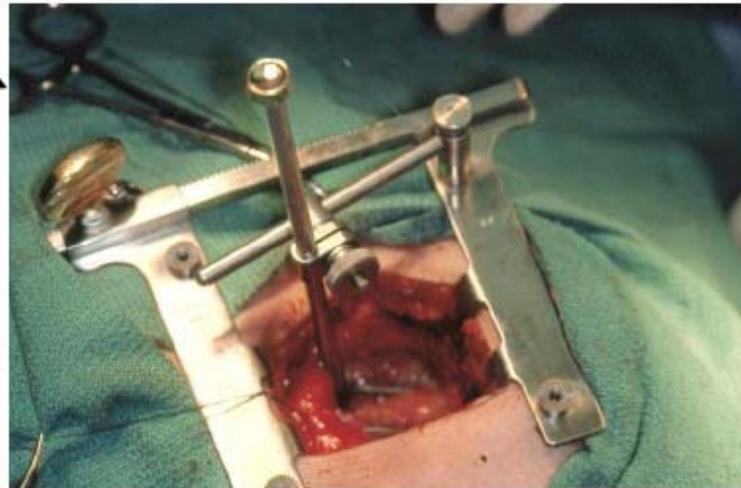
To use **smaller incisions**

- reduce the operative trauma
- preserve the integrity of the chest
- more cosmetic

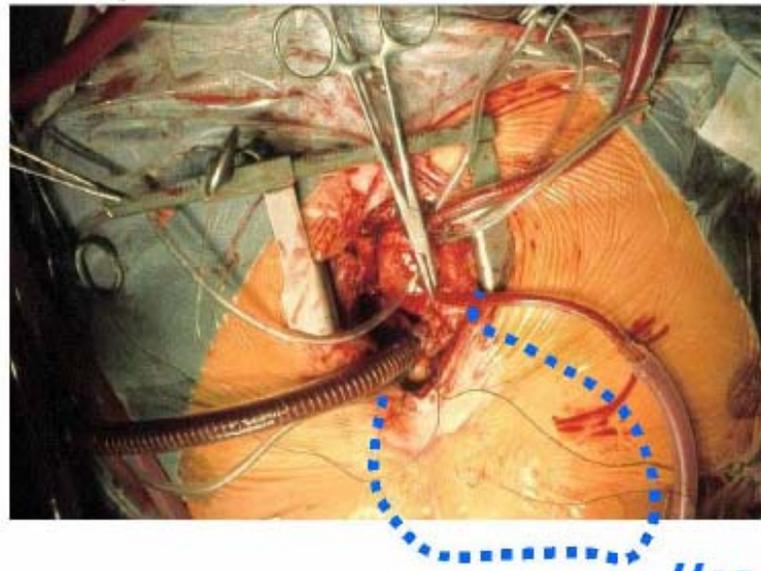
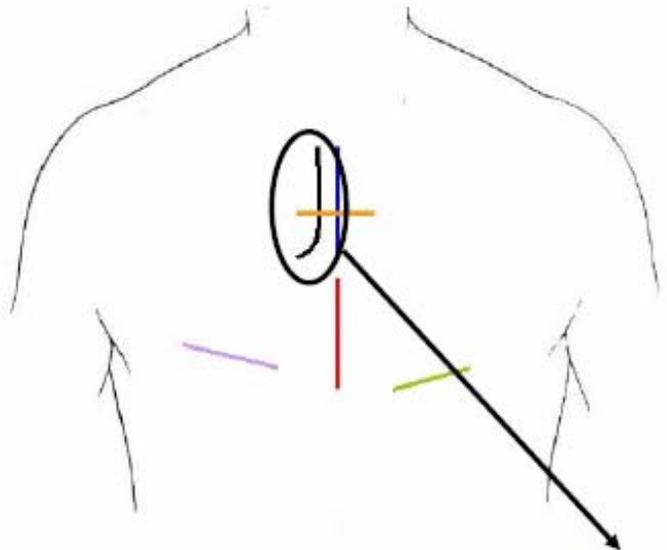
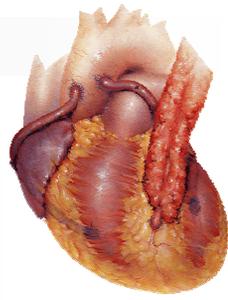




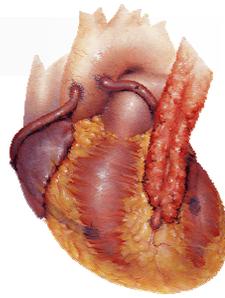
MIDCAB procedure



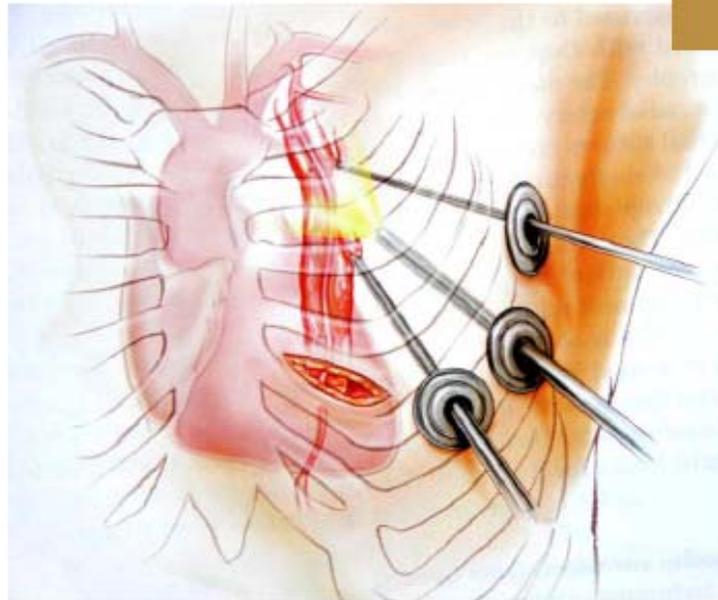
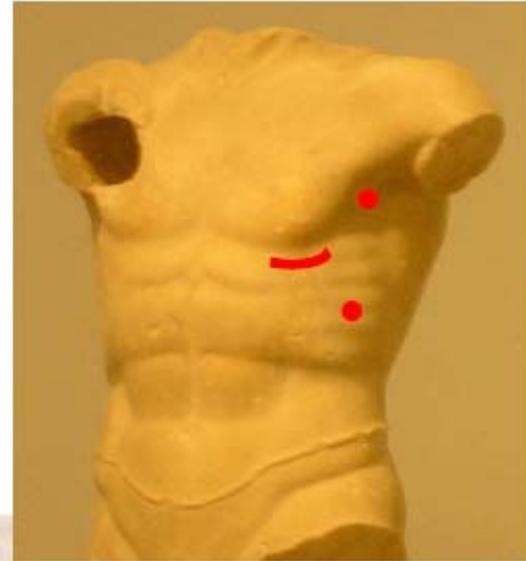
*Minimally invasive surgery may be performed
under direct vision*



Heart area



But true minimally invasive surgery is performed by passing an endoscope and surgical instruments through tiny incisions



Minimally invasive cardiac surgery



- **MICS remained far behind other specialties:**
 - High quality standard of cardiac surgery
 - Many constraints of cardiac surgery (motion of the heart, limited duration of the induced cardiac arrest)

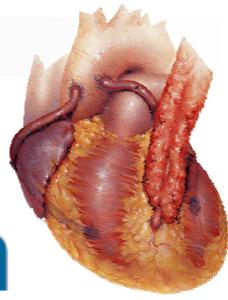
MICS was progressively introduced owing to progress in cardiopulmonary bypass, intracardiac visualization, and instrumentation

Many cardiac surgeons remains very critical of MICS because surgery might be unsafe and/or results less satisfactory

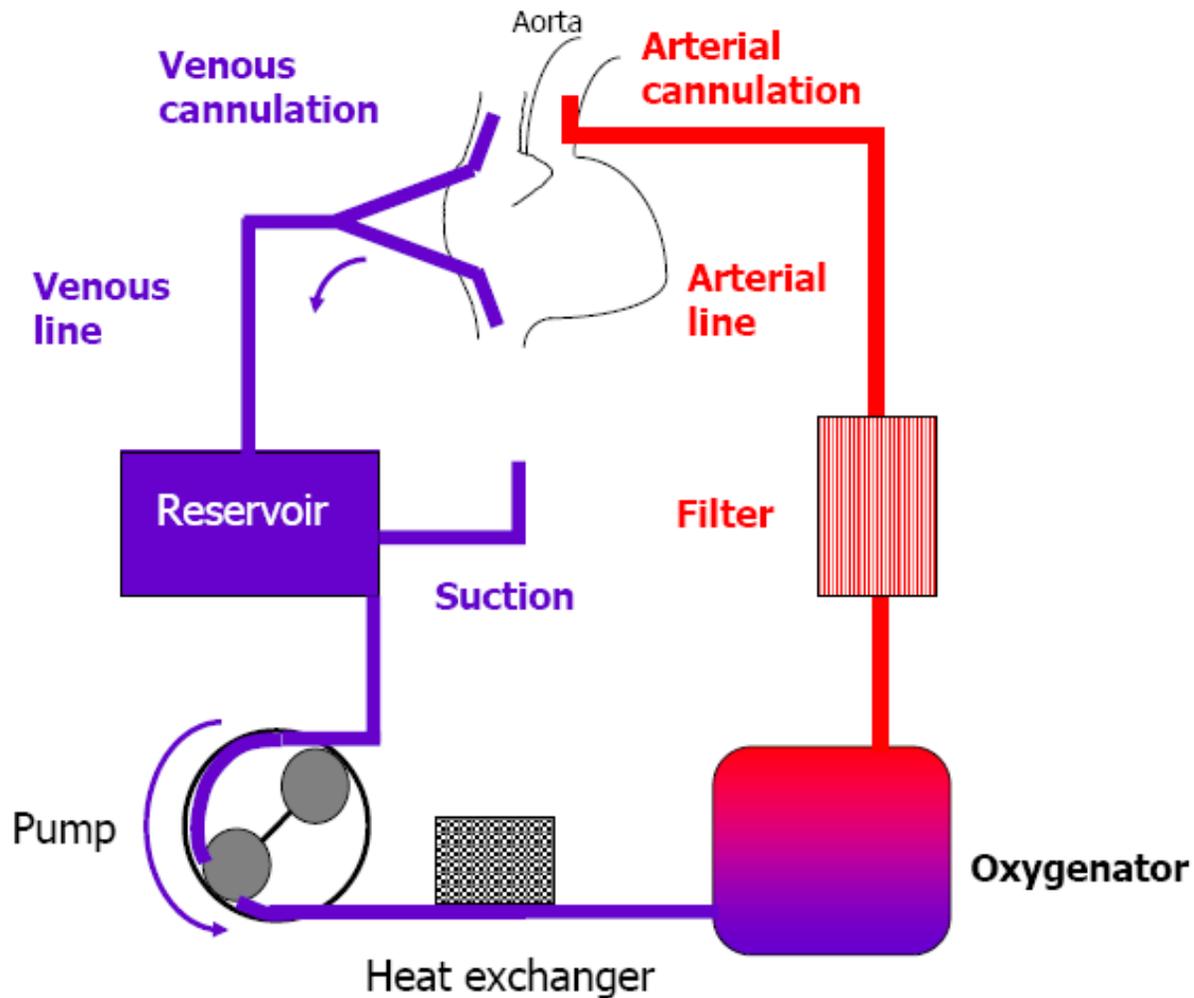


Heart-lung machine

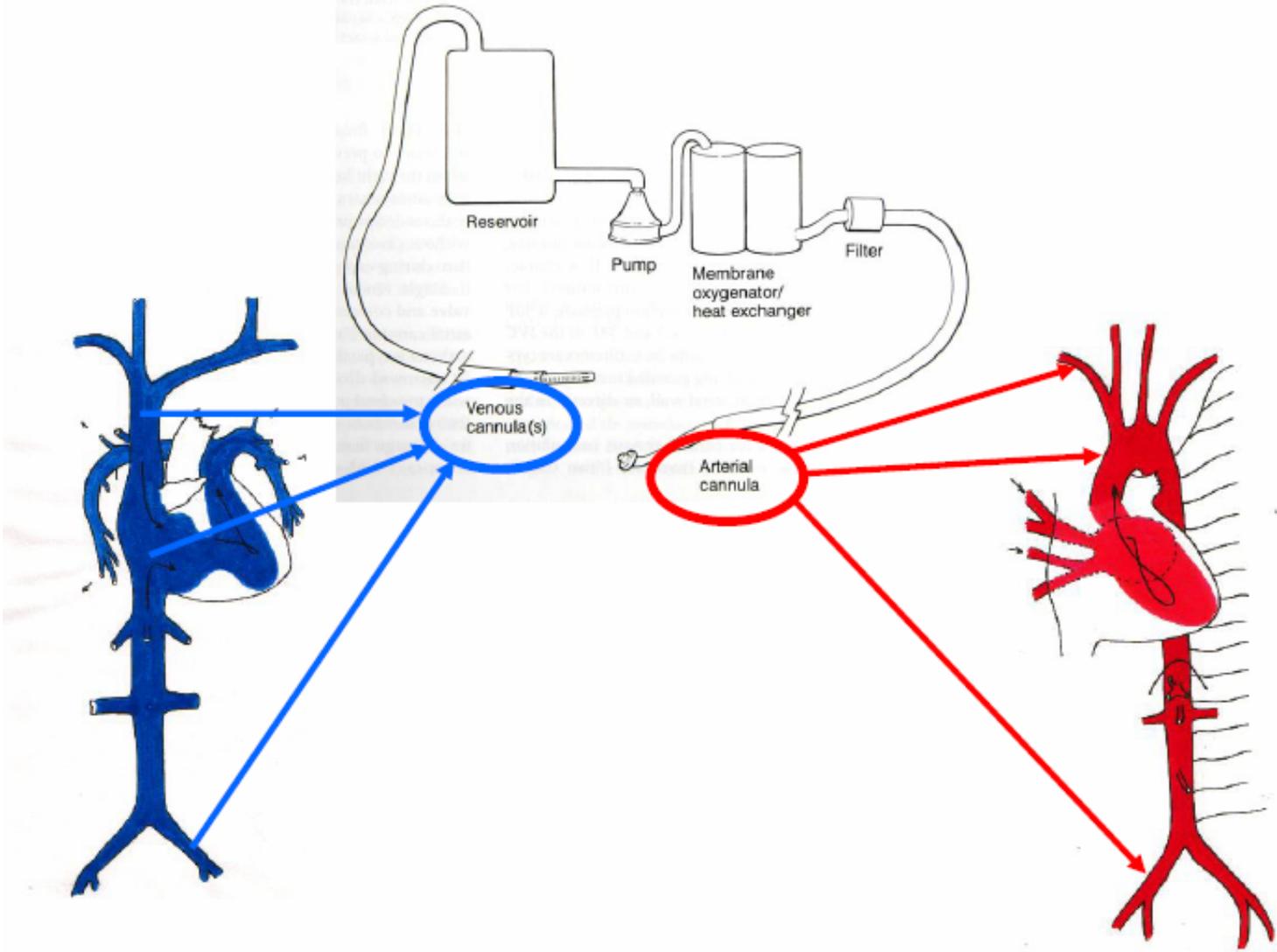
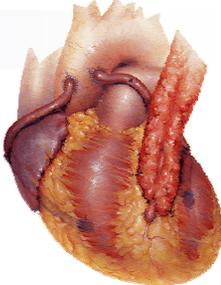
The extracorporeal circulation (ECC)

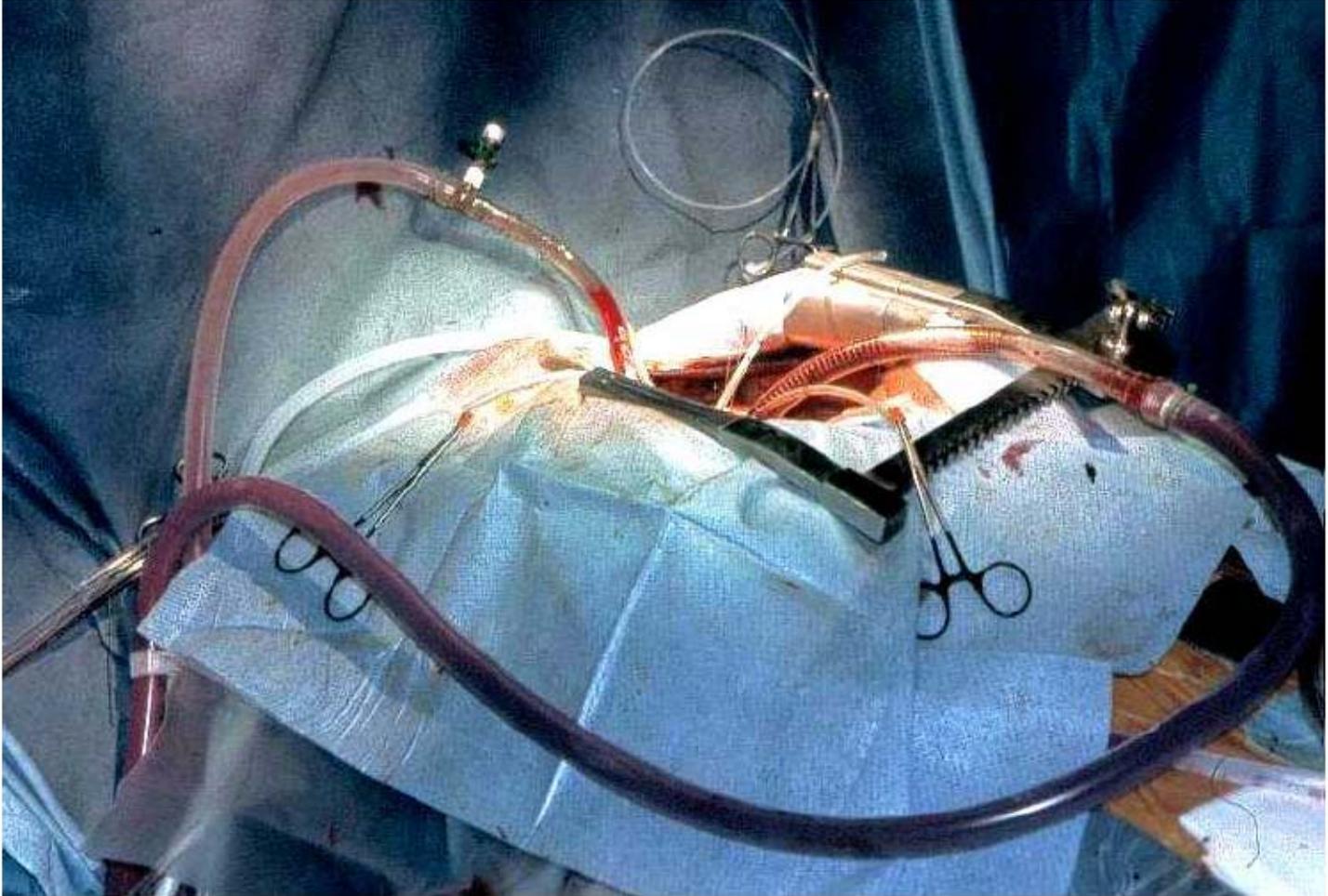
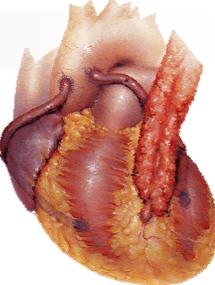


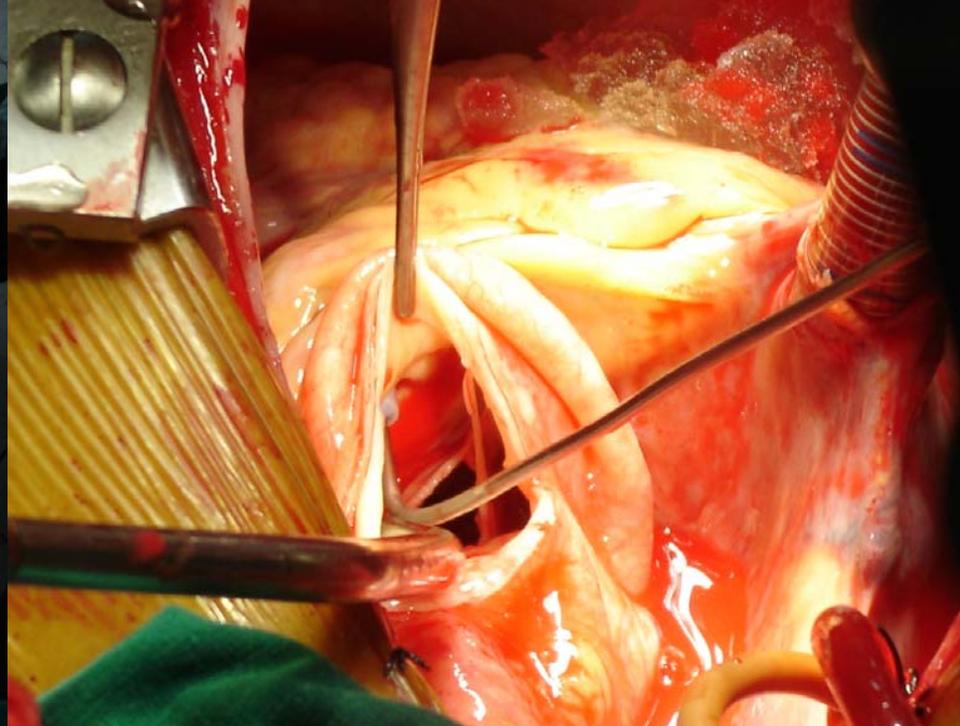
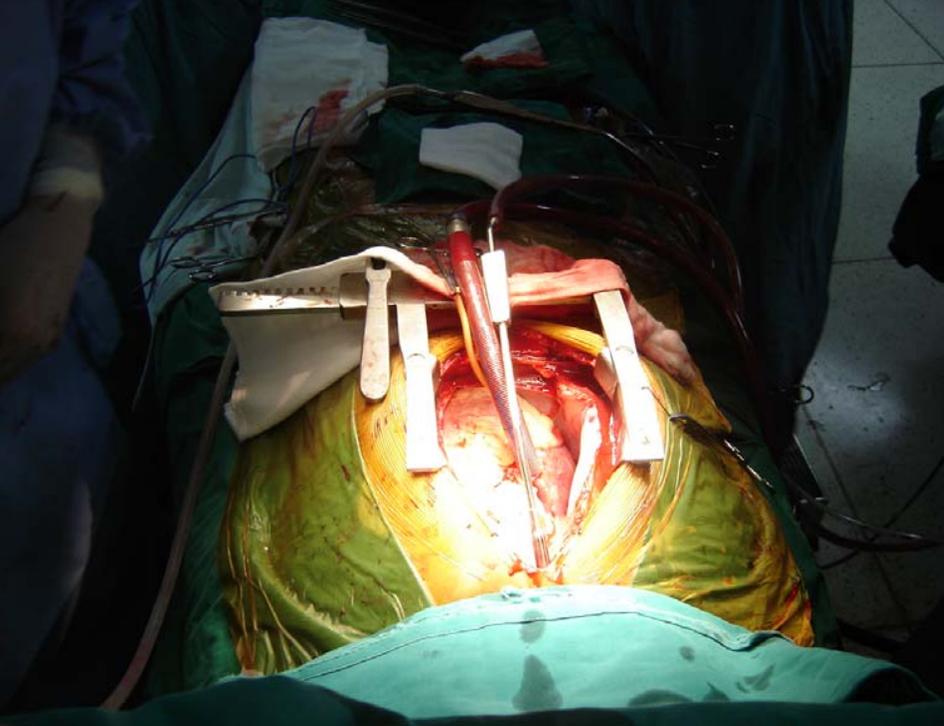
The extracorporeal circulation

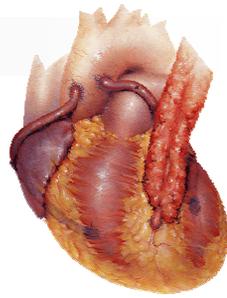


Adapted From: Hessel EA II, Edmunds LH Jr, *Extracorporeal Circulation: Perfusion Systems*, In: Cohn LH, Edmunds LH Jr, eds, *Cardiac Surgery in the Adult*, New York: McGraw-Hill, 2003:317338,



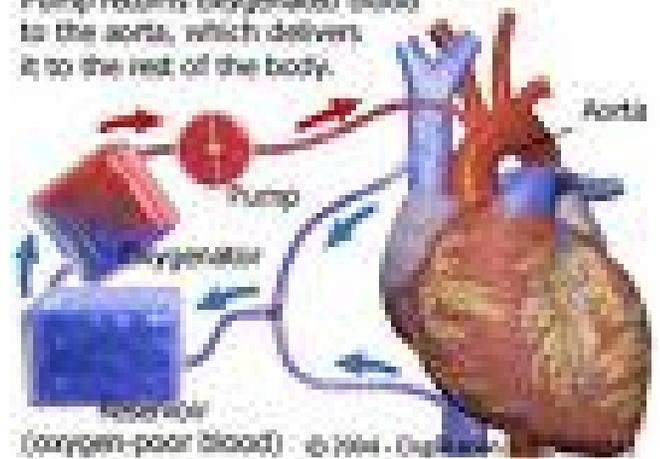


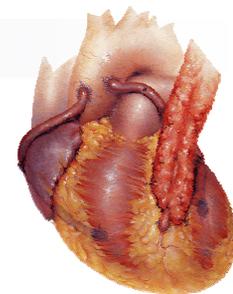




Heart-Lung Machine

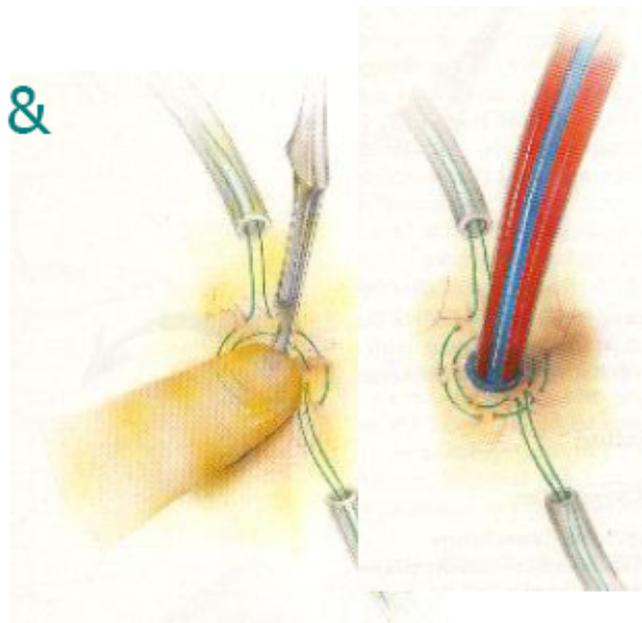
Pump returns oxygenated blood to the aorta, which delivers it to the rest of the body.





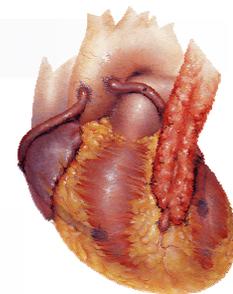
Operation under ECC (1)

- **Sternotomy**
- Opening of the pericardium & exposure of the heart
- Confection of **pursestring**



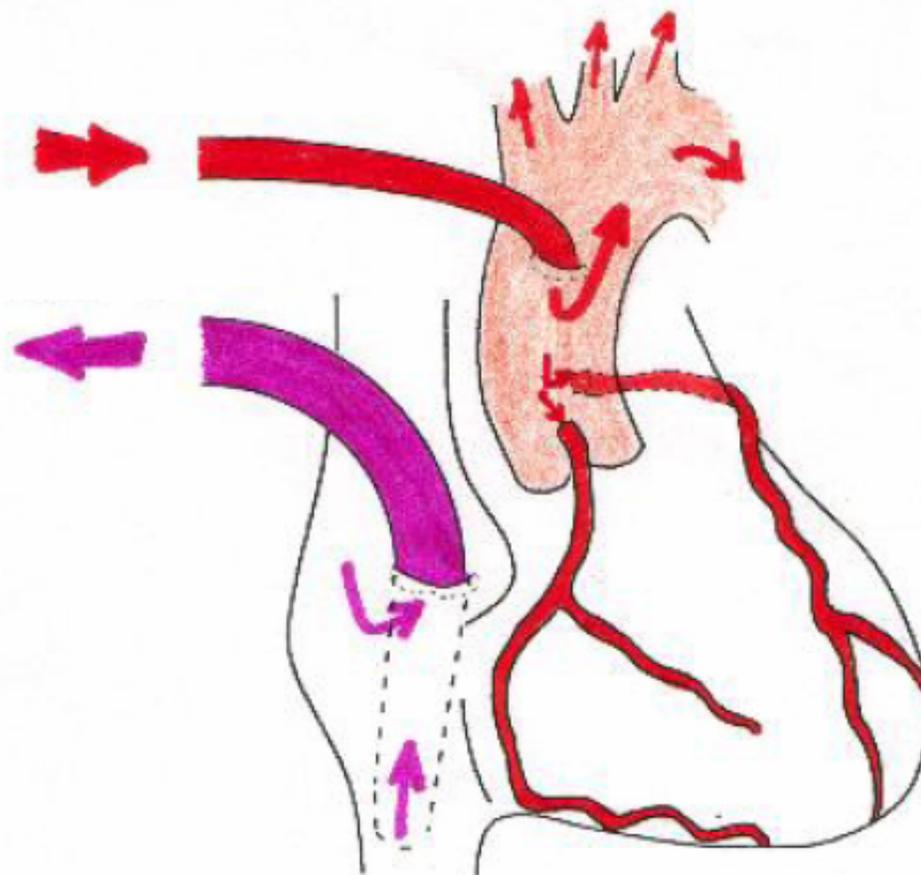
From : Manual of Cardiac Surgery, Harlan & Starr, Springer-Verlag, New York , 1995

- **Heparin: high dose**
- **Cannulation, connections to tubing**

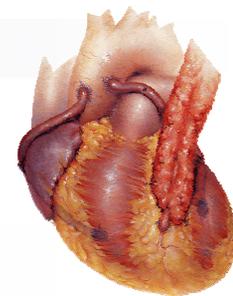


Operation under ECC (2)

- Initiation of ECC

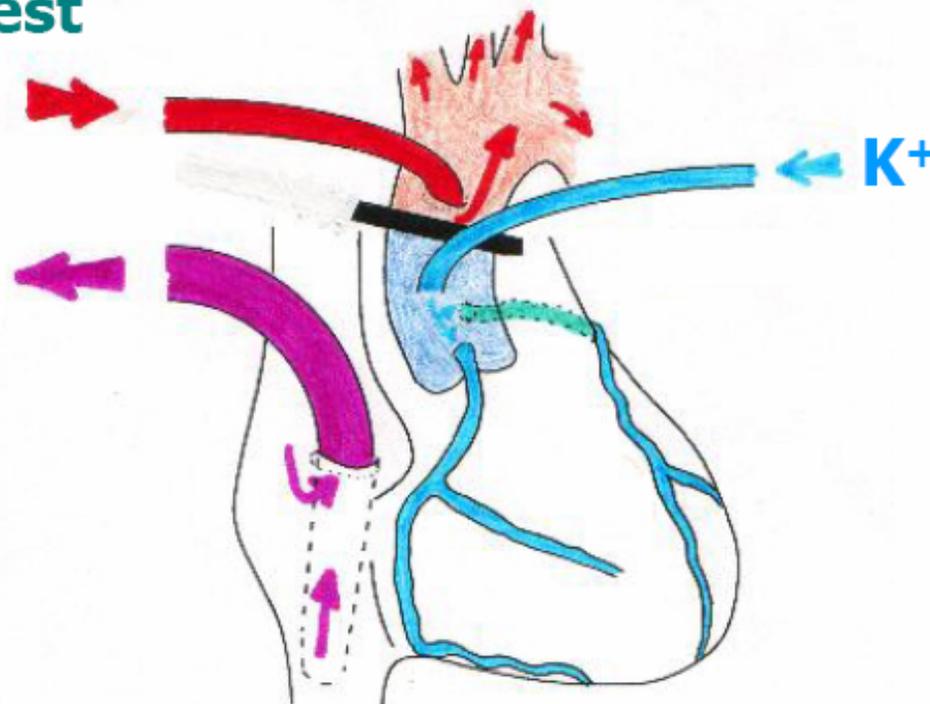


- Cooling

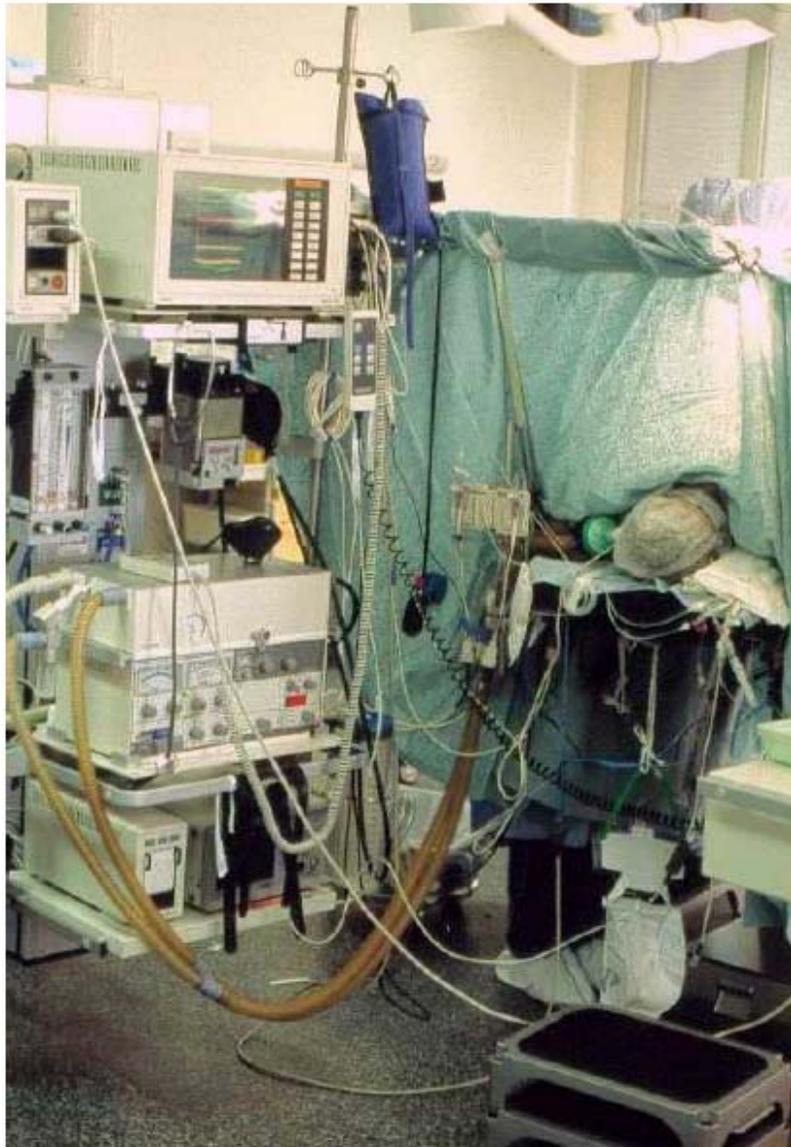


Operation under ECC (3)

- **Cardioplegic arrest**



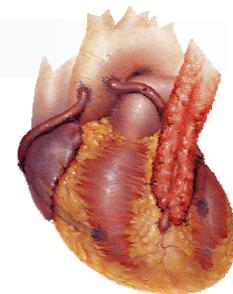
- Clamping of the aorta
- K^+ injection into the coronary system:
« *chemical arrest* » of the heart » , flaccid heart



Procedure

Heart arrested (ECG : no activity)

Lungs deflated

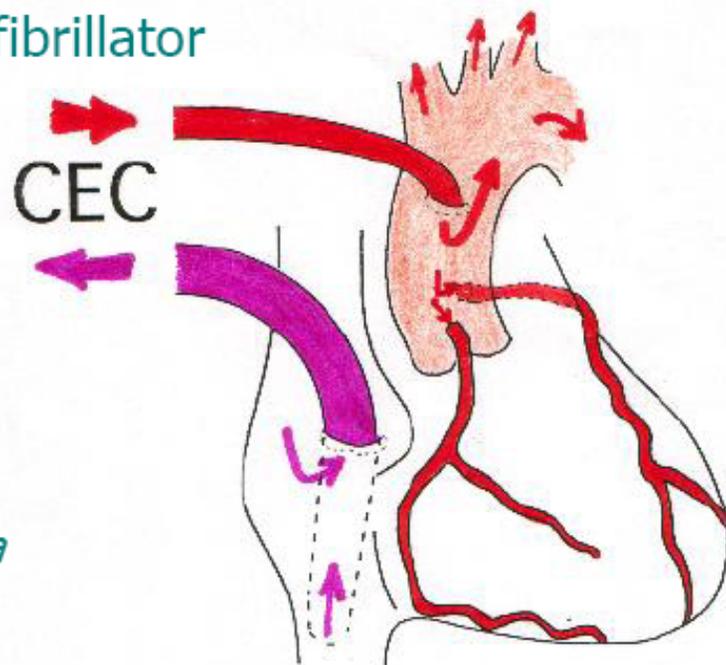


Operation under ECC (4)

- **Release of the aortic clamp**
 - Sinusal rhythm
 - Ventricular fibrillation: defibrillator
 - Block: pace-maker

Sinusal rythm

*If open-heart surgery
deairing before unclamping the aorta
(air embolization)*

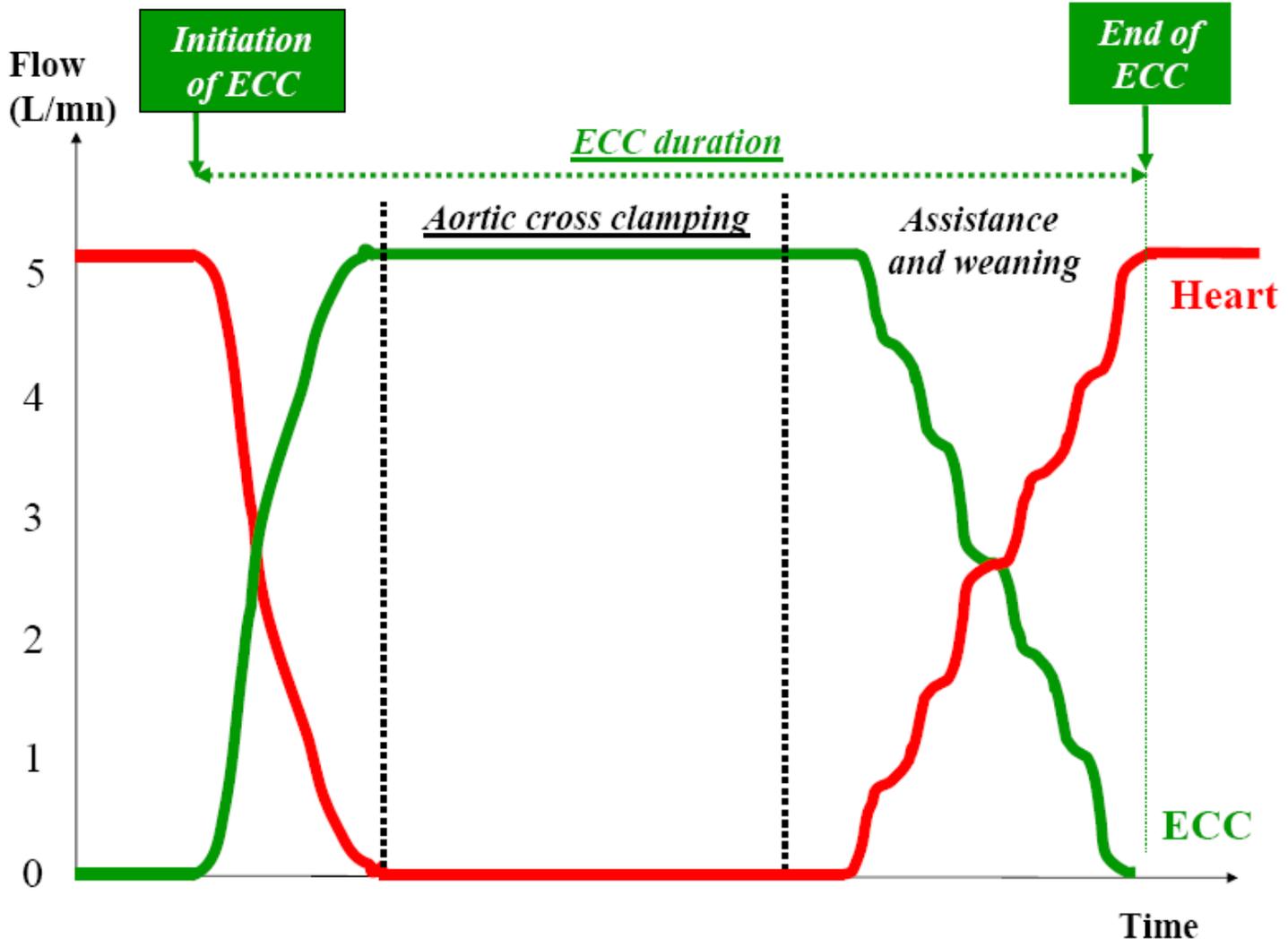
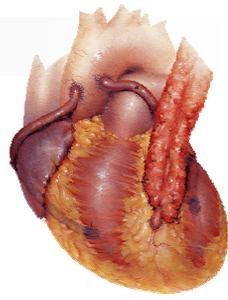


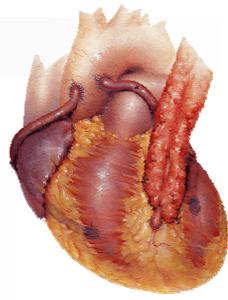


Operation under ECC (5)

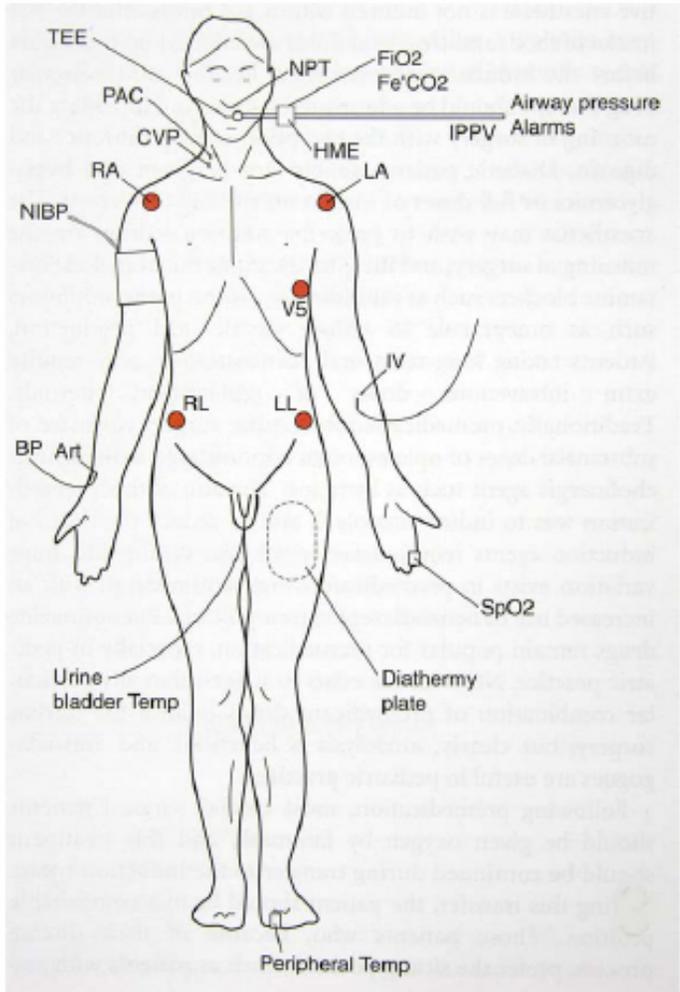
- **Assistance**
 - Recovery of the heart
 - Rewarming
- **ECC discontinuation**

progressive weaning: transition between ECC and native circulation
- **Once hemodynamic stability is acquired**
 - Remove of cannula
 - Administration of protamine (restoration of coagulation)
- **Drainage**
- **Closure**

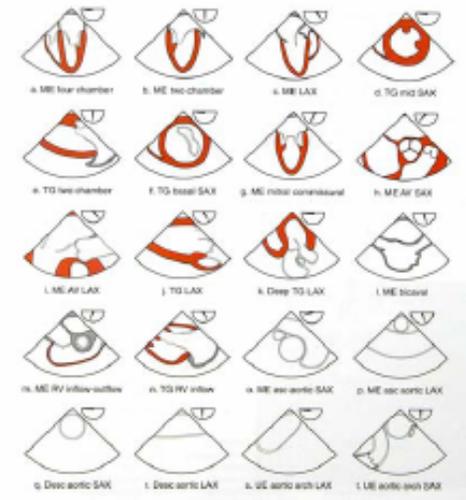




Equipment - Monitoring



ECG and hemodynamic monitoring



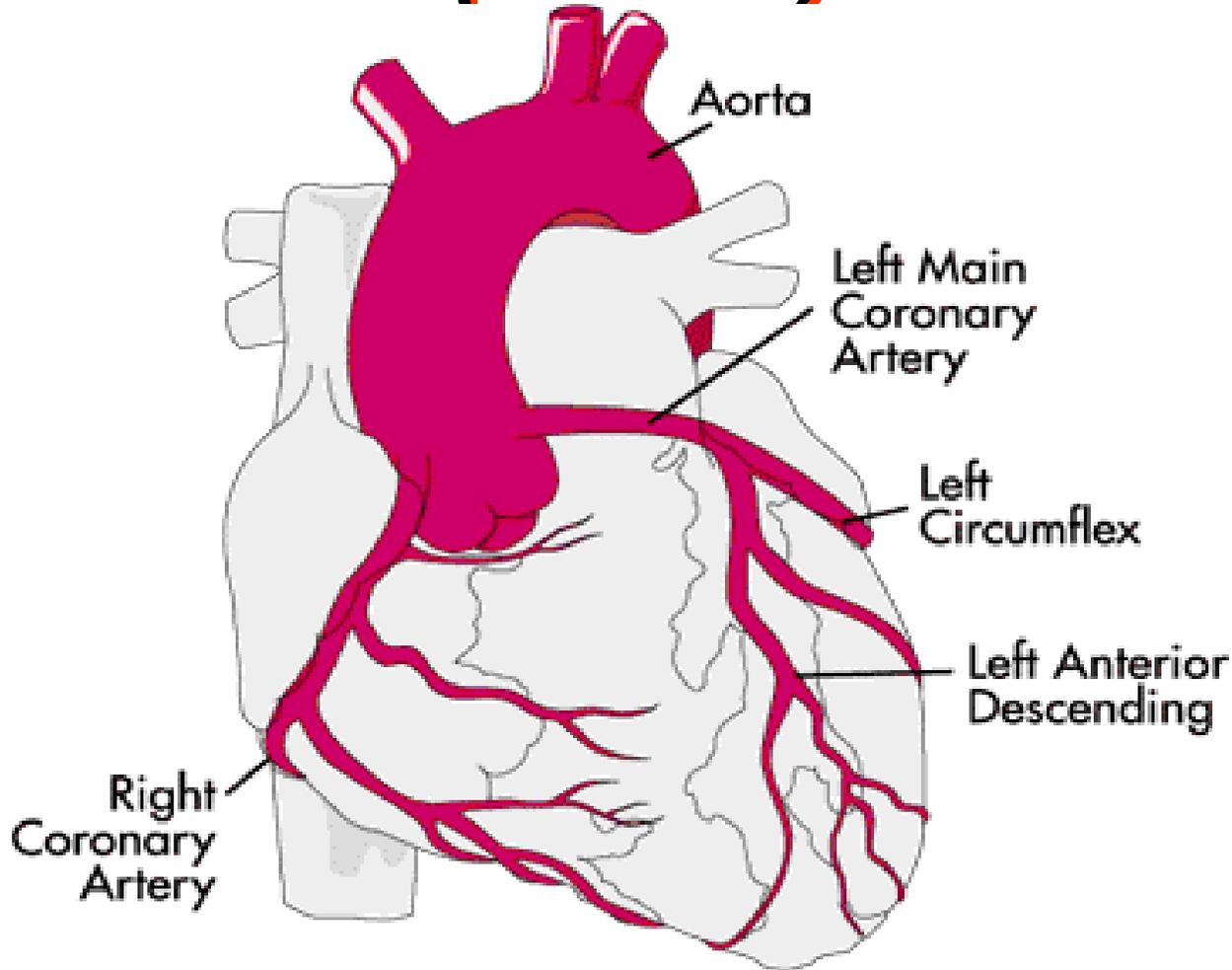
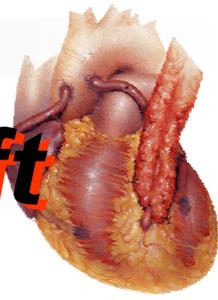
Transesophageal echocardiography monitoring

Preoperative imaging

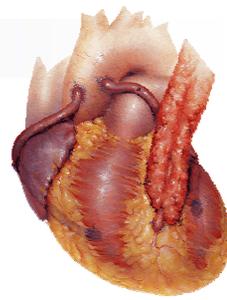


- Coronarography Video
- Echocardiography Video
- CT-scan
- MRI

Coronary Artery Bypass Graft (CABG)



Indications for Surgery



- Chronic angina
- Unstable angina
- Acute myocardial infarction
- Acute failure of percutaneous transluminal coronary angioplasty (PTCA)
- Severe coronary artery disease
- Complication from AMI such as acute mitral regurgitation or ventricular septal defect (VSD)

Assessment of risk



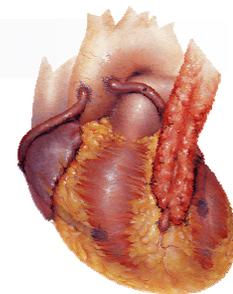
Euroscore

- Age - for each 5 years over 60 years +1%
- Female sex +1%
- Chronic respiratory disease +1%
- Extracardiac arteriopathy +2%
- Neurological dysfunction +2%
- Creatinine greater than 2.0 +2%
- Previous cardiac surgery +3%
- Unstable angina +2%
- Recent myocardial infarction +2%
- Good ejection fraction Nil
- Moderate ejection fraction +1%
- Poor ejection fraction +3%

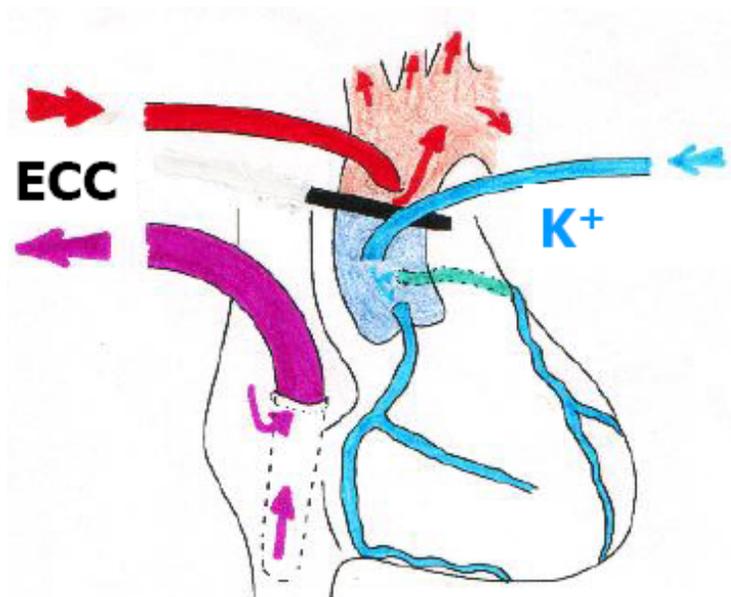
Conventional CABG Procedure



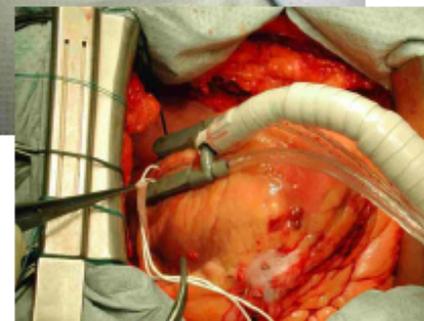
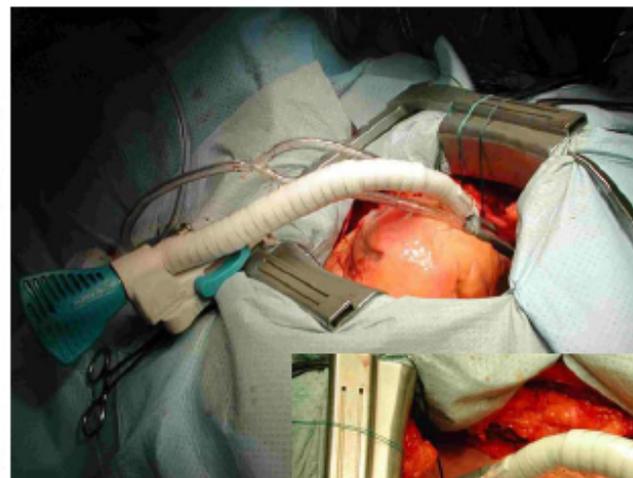
- Conduit removed
- Median sternotomy
 - Sternum divided using electric saw
- Cold potassium cardioplegia
- Cardiopulmonary bypass
 - Cannulation of:
 - Ascending aorta
 - Femoral artery
 - Right atrium
 - Heparin administered to minimize clotting



CABG – Operative technique

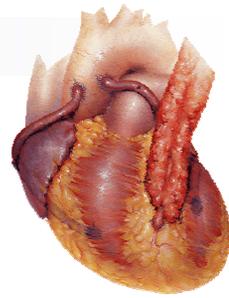


**Under ECC with
cardioplegia**

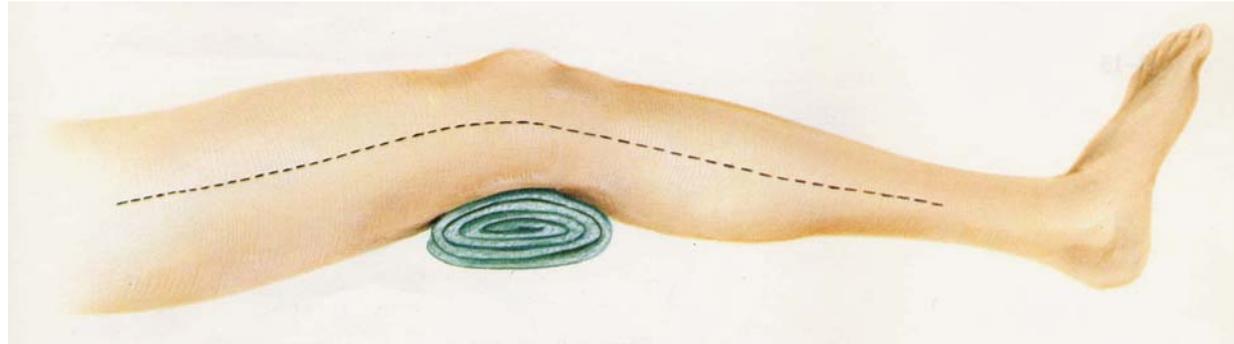


**Beating-heart surgery
(without ECC)**

Conduits Used for Bypass

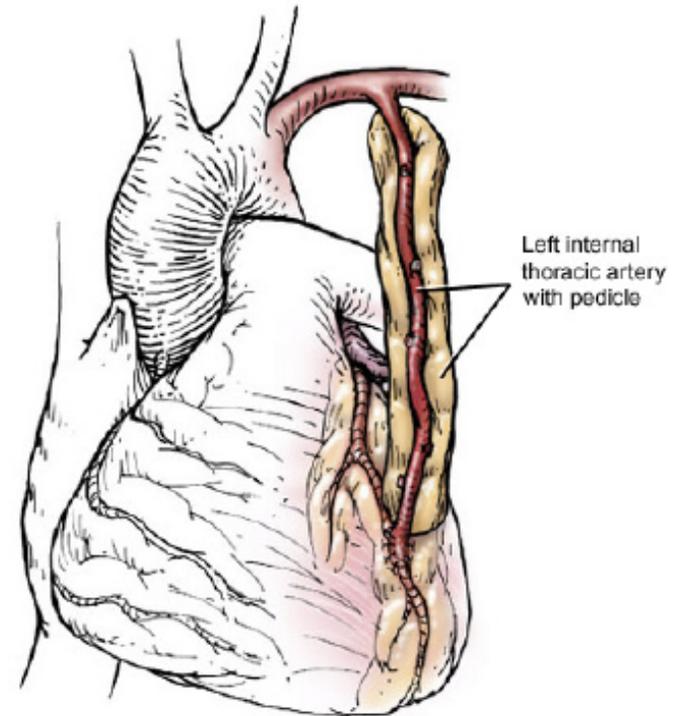
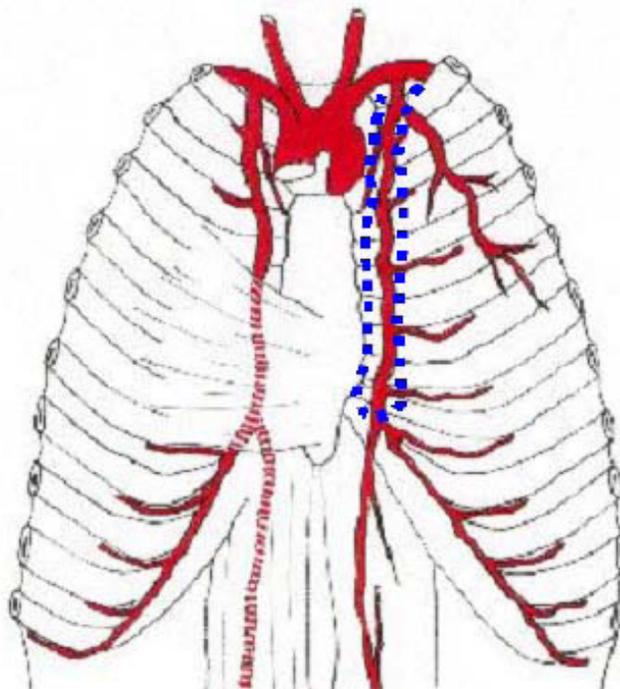
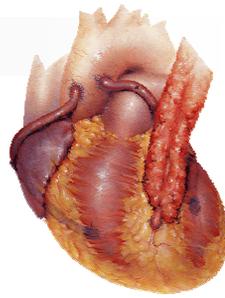


- Saphenous vein used for bypassing right coronary artery and circumflex coronary artery

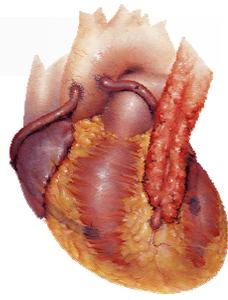


- Internal mammary artery (IMA) used for bypassing left anterior descending coronary artery
 - Patency rate over 90% after 10 years
- If more veins are needed, alternative sites such as upper extremity veins can be used
 - Patency rate as low as 47% after 4.6 years

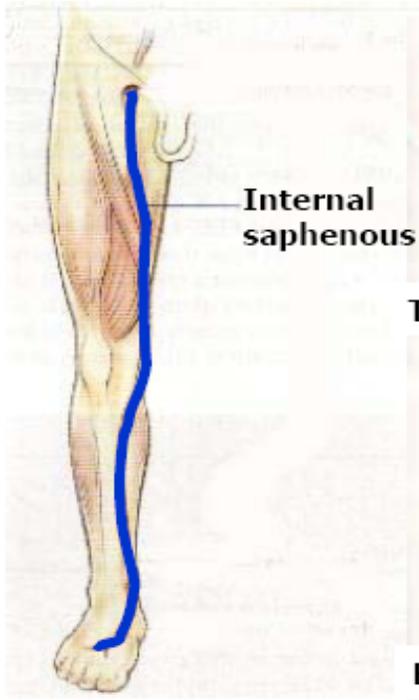
Internal thoracic artery graft



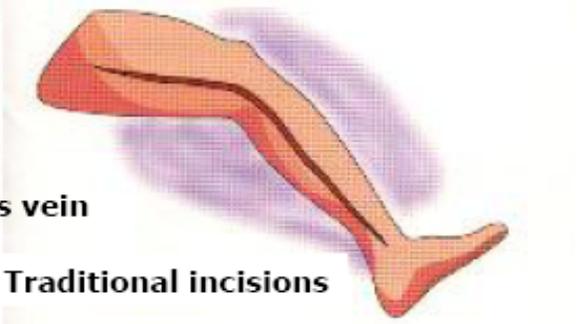
From: The Society of Thoracic Surgeons Web site
<http://www.sts.org>



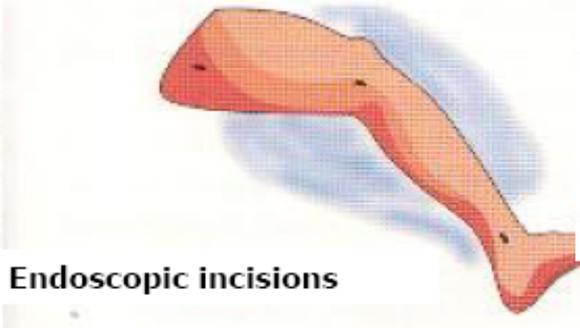
Saphenous vein graft



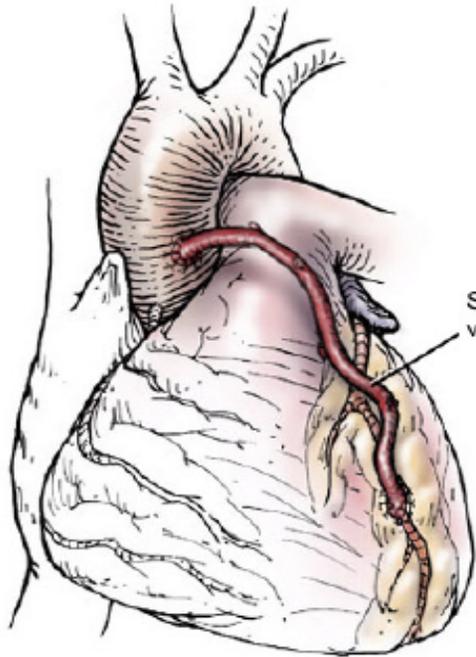
Internal saphenous vein



Traditional incisions

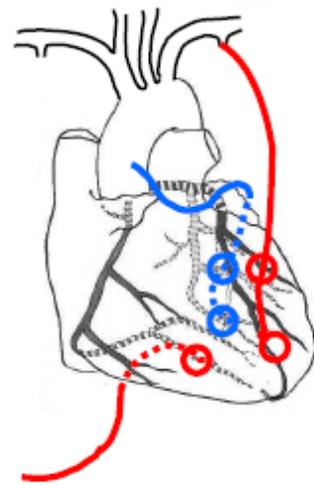
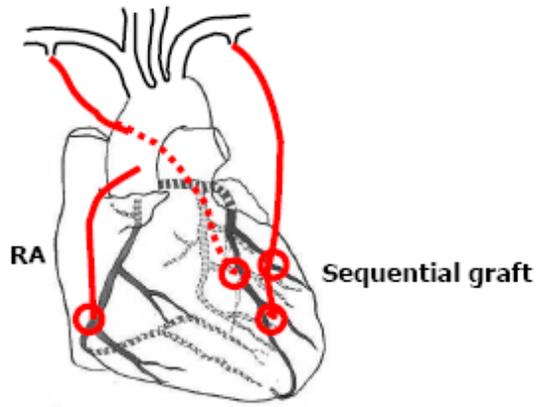
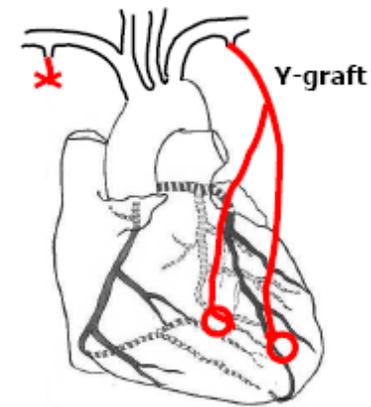
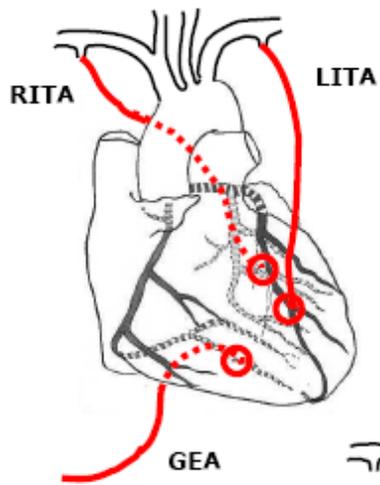
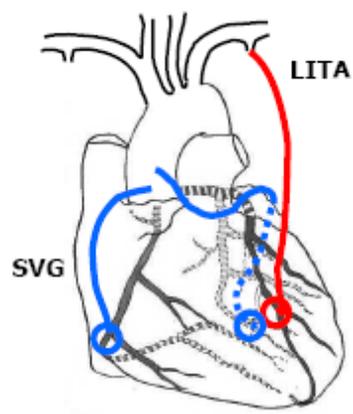
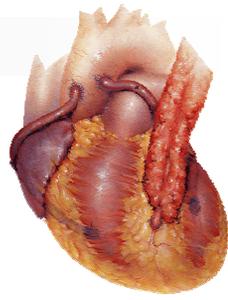


Endoscopic incisions



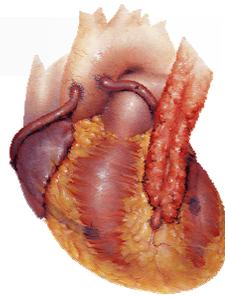
Saphenous vein graft

From: The Society of Thoracic Surgeons Web site
<http://www.sts.org>

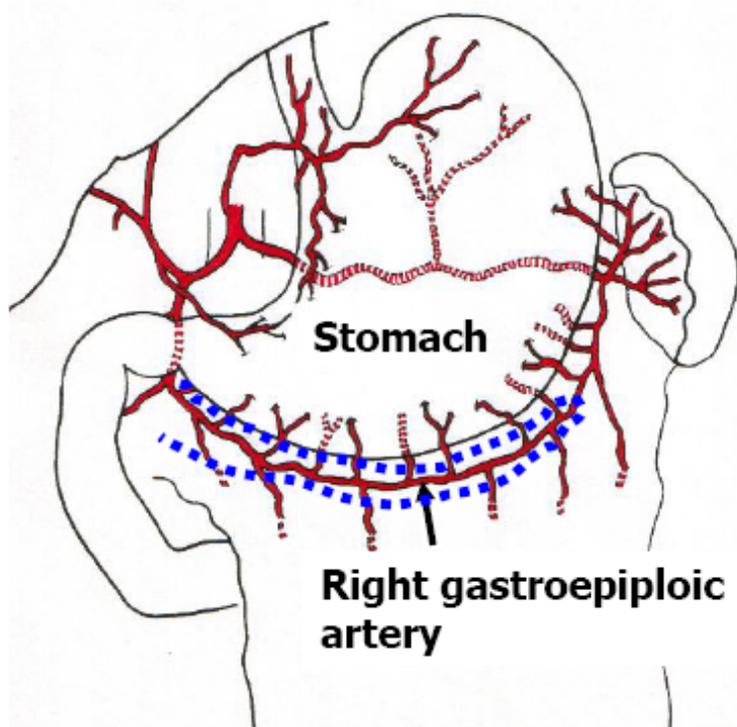


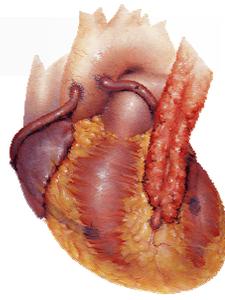
Some example of CABG
Various combinations are possible
Arterial graft must be favored

LITA: left internal thoracic artery
RITA: right internal thoracic artery
GEA: gastroepiploic artery
SVG: saphenous vein graft
RA: Radial artery

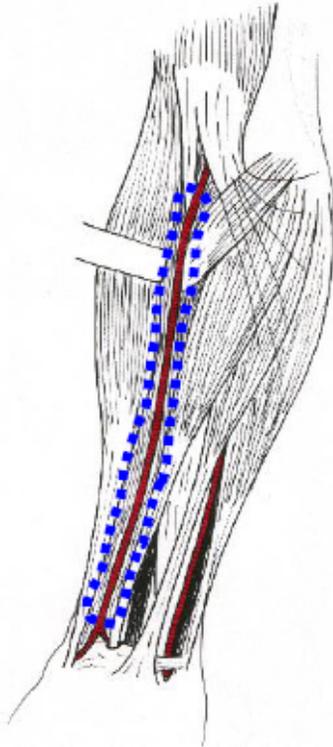


Other arterial grafts

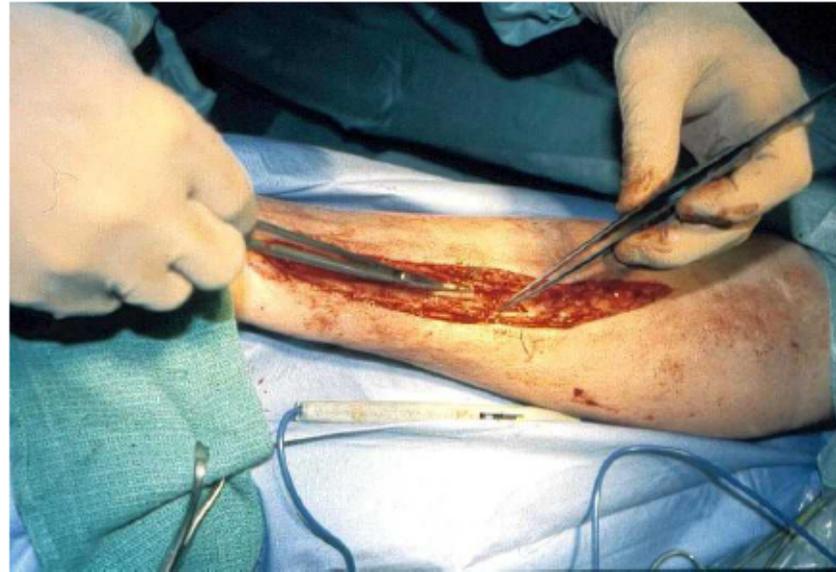




Other arterial grafts



Radial artery





Valvular surgery



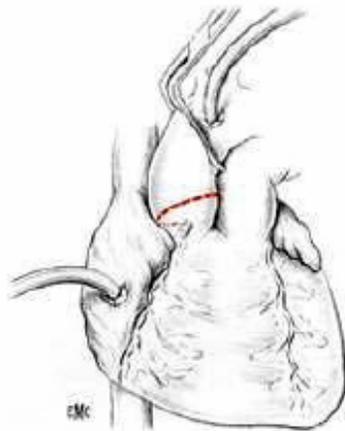
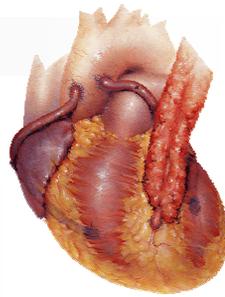
Generality

In adult, valvular surgery is mostly used for the aortic valve and mitral valve

Repair must be favored because of a higher valve prosthesis morbidity

- **Aortic valve**
 - Aortic valve replacement: most cases
 - Valvuloplasty: some cases
- **Mitral valve**
 - Valvuloplasty: most cases
 - Mitral valve replacement if valvuloplasty is impossible

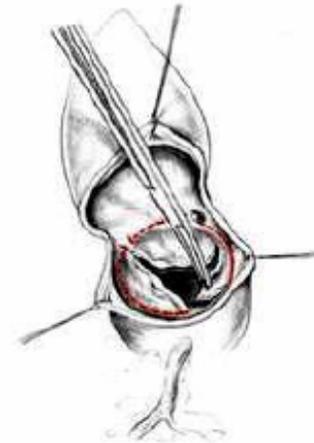
Aortic valve replacement



A



B



C

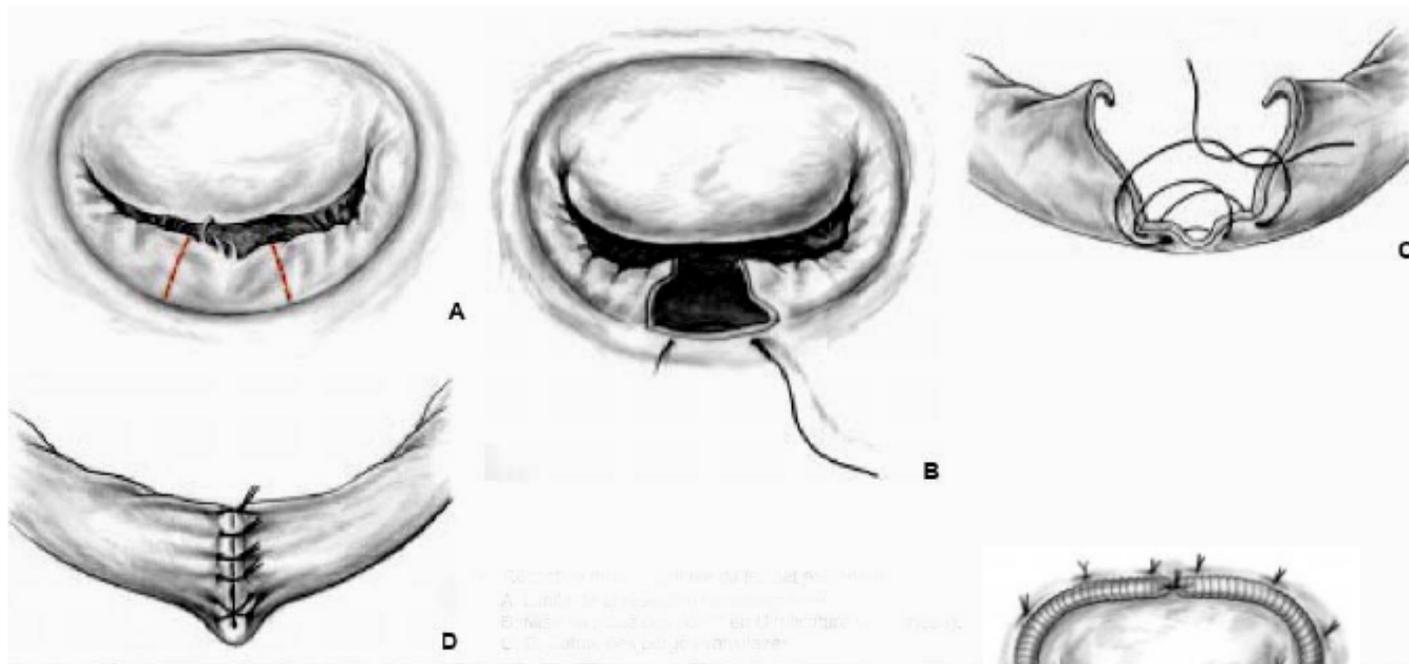
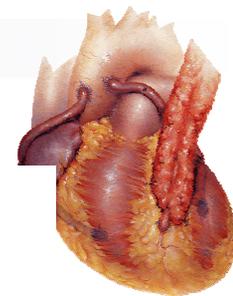


D

Video

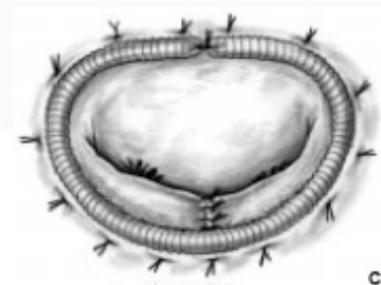
From : *Chirurgie des lésions acquises de la valve aortique*, Leguerrier et al, in *Traité de Techniques chirurgicales - Thorax* : 42-570, Encycl Méd Chir , Elsevier, Paris, 1996

Mitral valve repair

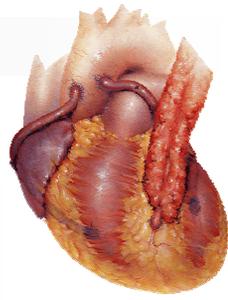


Technique de réparation de la valve mitrale
A. Ligne de réparation de la valve mitrale
B. Mise en place d'un patch de réparation de la valve mitrale
C. Suture de la valve mitrale réparée

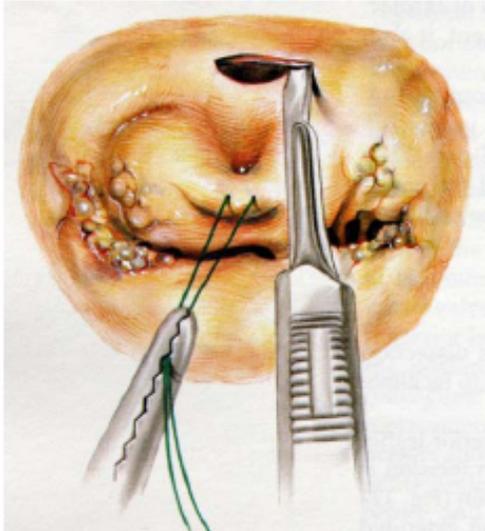
Video



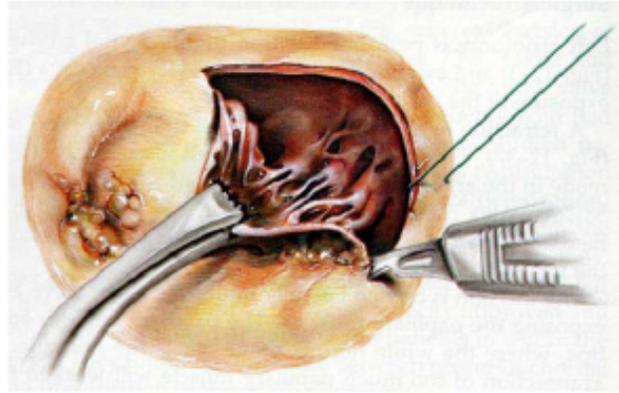
From : *Chirurgie des lésions acquises de la valve mitrale (II)*, Fuzellier et al, in *Traité de Techniques chirurgicales - Thorax* : 42-531, Encycl Méd Chir , Elsevier, Paris, 1999



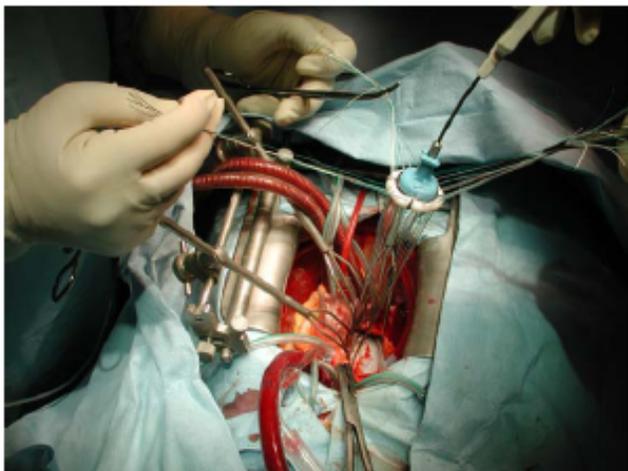
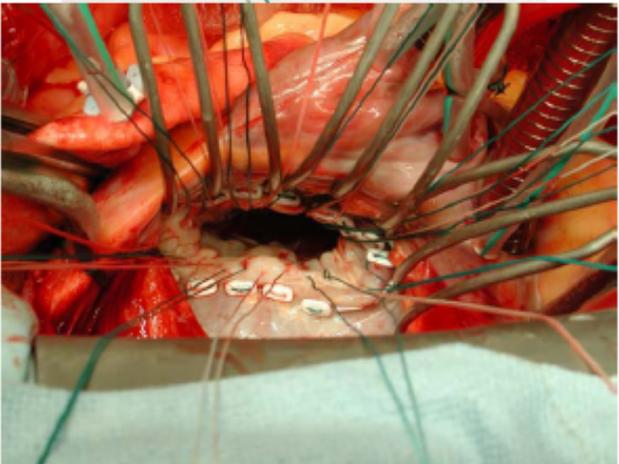
Mitral valve replacement



Video



From : Manual of Cardiac Surgery, Harlan & Starr, Springer-Verlag, New York , 1995





Side Effects of CPB

- Creates a shock-like state :
 - ◆ Low Hct (hemodilution)
 - ◆ ↓ systolic BP
 - ◆ ↓ perfusion of organs & tissues
 - ◆ Platelet destruction & RBC hemolysis
 - ◆ Post-op coagulation problems
 - ◆ Aortic cross clamping (thrombus)



Postoperative Care

- Monitor HR, a-line, CVP, PWP, CO
- Check peripheral pulses/apical
- Warm pt slowly
- Assess cap refill & skin color
- UO q one hour
- Pace settings
- Chest tube drainage
- K & Mg /lytes



Respiratory Function

- Ventilation Goal SpO₂ >95%
- Wean & extubate ASAP



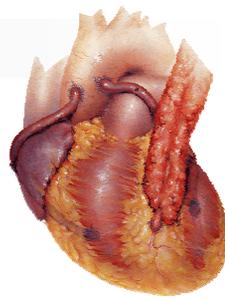
Chest tube drainage & bleeding

- Mediastinal tubes
 - ◆ Observe & document output = usually declines in the first few hours
 - ◆ Monitor Hgb
 - ◆ If >200cc's for > 3 hours needs aggressive Tx
 - ◆ #1 R/O coagulopathies



What are the major causes of abn.coagulation times?

- INR (1-1.2 sec or PT 12-12 sec)
 - ◆ Prolonged Coumadin, hepatic dysf.
- aPTT (35-45sec)
 - ◆ Prolonged by Heparin
- Bleeding time (2-8min)
 - ◆ ASA, NSAID's, valve problems,
- Platelet Ct (150,000-400,000)
 - ◆ Infection, drugs, hematologic

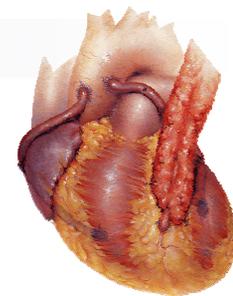


Criteria for return to OR

- Bleeding > 400 ml/hour for 3 hours

Or

- Bleeding > 100 ml/ hour for 6 hours



Cardiac Tamponade

- Pressure on the heart caused by accumulation of blood in the pericardium
- Occurs if patient is bleeding & mediastinal tubes are not kept patent
 - ◆ R heart pressure (CVP) = L heart pressure (PWP)



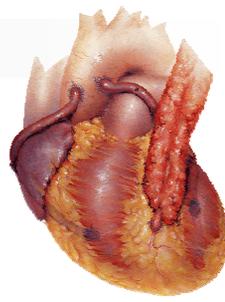
Renal

- Initially diuresis $> 100 - 200$ cc's/hour
- Monitor BUN & Cr.



Hypothermia

- Prevent shivering
- Temperature



Neurological care

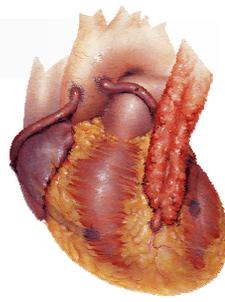
- Monitor LOC
- Pupils
- Ability to follow commands
- Strength & movement of extremities

Postop Labs



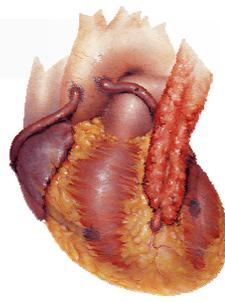
- Hgb/Hct
- PT/PTT
- Na, K, Cl
- BUN/Cr
- ABG/Glucose
- Troponin
- EKG/Chest xray

How can one tell if the pt is doing well?



- UO>30cc/hr
- HR within 60-100
- Ventilating well
- Chest tube output under control
- EKG changes
- Pulses
- Normothermic
- ? Inotropics

Most common abn in the early postop period



- ↓BP, ↓T, ↓ K, ↓ Mg
- Anemia
- Bradyarrhythmias
- Respiratorot failure
- SVT
- Bleeding
- Ventricular arrhythmias



Low CO syndrome

- CHF = Low CO syndrome
- Underperfused tissues & congested organs due to ↓ CO
- $CI < 2.0$ l/min/m²

- Most common complication in the early postop period

BYE-BYE



Any Problem?



