Cardiopulmonary Bypass

Denise Traxler
1812: Le Gallois showed that extracorporeal circulation is possible
1858: Brown-Sequard arterialized desaturated blood
1869: Ludwig & Schmid first reported of an artificial oxygenator
1882: first “bubble”-oxygenator by von Schroeder
1884: first “film”-type oxygenator
first prototype of a heart-lung-machine
History

1890: Jacobj described an device with a bubble oxygenator & bladder pump in order to provide pulsatile flow
1915: Hooker invented an forerunner for the disk oxygenator
1916: discovery of heparin by McLean
      significant step in evolution of heart-lung-machine
1928: Dale & Schuster described the prototype pumping mechanism (valved pump)
1934: DeBakey modified the twin roller pump
John H. Gibbon

1931: idea of an extracorporeal blood circuit that could perform a part of the cardiorespiratory function first occurred to him

cooperation with IBM (3 models)

„father of cardio-pulmonary bypass“
Gibbon’s heart-lung-machine:

Debakey roller pumps

film oxygenator

1\textsuperscript{st} patient: a year old girl with a presumed large atrial septal defect

2\textsuperscript{nd} patient: 18 year old woman with a large atrial septal defect

STONEY WS (2009). Evolution of Cardiopulmonary Bypass
STAMMERS AH (1997). Historical Aspects of Cardiopulmonary Bypass: From Antiquity to Acceptance
GIBBON JH (1973). The Development of the Heart-Lung Apparatus
History

further development by John Kirklin (Mayo-Gibbon heart-lung machine)
Walton Lillehei’s cross circulation

- donor: mother/father
- 28 survivors of 45 operations
- 2 serious accidents involving the donor parents

Cessation of this method because of high risk for donor parents (200% mortality) and limited application
History

STONEY WS (2009). Evolution of Cardiopulmonary Bypass
Walton Lillehei’s heart-lung-machine

bubble oxygenator (DeWall oxygenator)

Sigmamotor pump

disposable plastic tubing

inexpensive

“can opener to the cardiac surgery picnic”
Unpractical/not realistic ideas

1950s: Dodrill had the intention to bypass only the right/left heart (without oxygenation) or to use the patients own lung as an oxygenator

William T. Mustard used a monkey lung oxygenator
first attempts at cardiopulmonary bypass in the 1950s were a series of disasters, as

- everyone built his own device
- surgeons were inexperienced with this new technology
  - poor myocardial protection
  - accidental intraoperative air embolism
  - postoperative bleeding
- only the sickest patients were referred to surgeons
- error rate in preoperative diagnosis was high

STONEY WS (2009). Evolution of Cardiopulmonary Bypass
1. anticoagulation which could be reversed at the end of the operation
2. method of pumping blood without destruction of red blood cells
3. oxygenation of blood & dissipation of carbon dioxide
hypothermia

has already been postulated in 1959 by Charles Drew, but did not gain wide acceptance because of rumours of neurological injuries

revival in the 1980s

prolongs hypoxic time
Principles

cardioplegia

4°C

arresting agents: potassium procaine magnesium

injection in the aortic root

blood cardioplegia
Principles
Application

heart-/lung transplantation
rupture of the aorta
atrial septal defect
coronary artery bypass
pulmonary embolectomy
valvular heart disease
ECMO

consists of a oxygenator & pump
application

supportive after heart-/lung transplantation/reanimation
pneumonia
bridge-to-transplant
ARDS
complications
bleeding
infection
air embolism

http://www.herz-lungen-maschine.de/herz-lungen-maschine/ecmo.html (December 16th, 2013)
ECMO

venoarterial
venovenous
venovenoarterial

http://www.herz-lungen-maschine.de/herz-lungen-maschine/ecmo.html (December 16th, 2013)