



心臟血管外科常見手術

許博順

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國防醫學院醫學系外科學科





心臟手術

- Coronary artery bypass grafting(**CABG**)
- **Valvular** heart surgery: replacement or repair of mitral valve, tricuspid valve or aortic valve.
- **Heart Transplantation**



大血管手術

- **Aortic dissection**: open, endovascular reconstruction or hybrid.
- **Aortic aneurysm**: open repair or endovascular repair.



體外循環生命支持系統

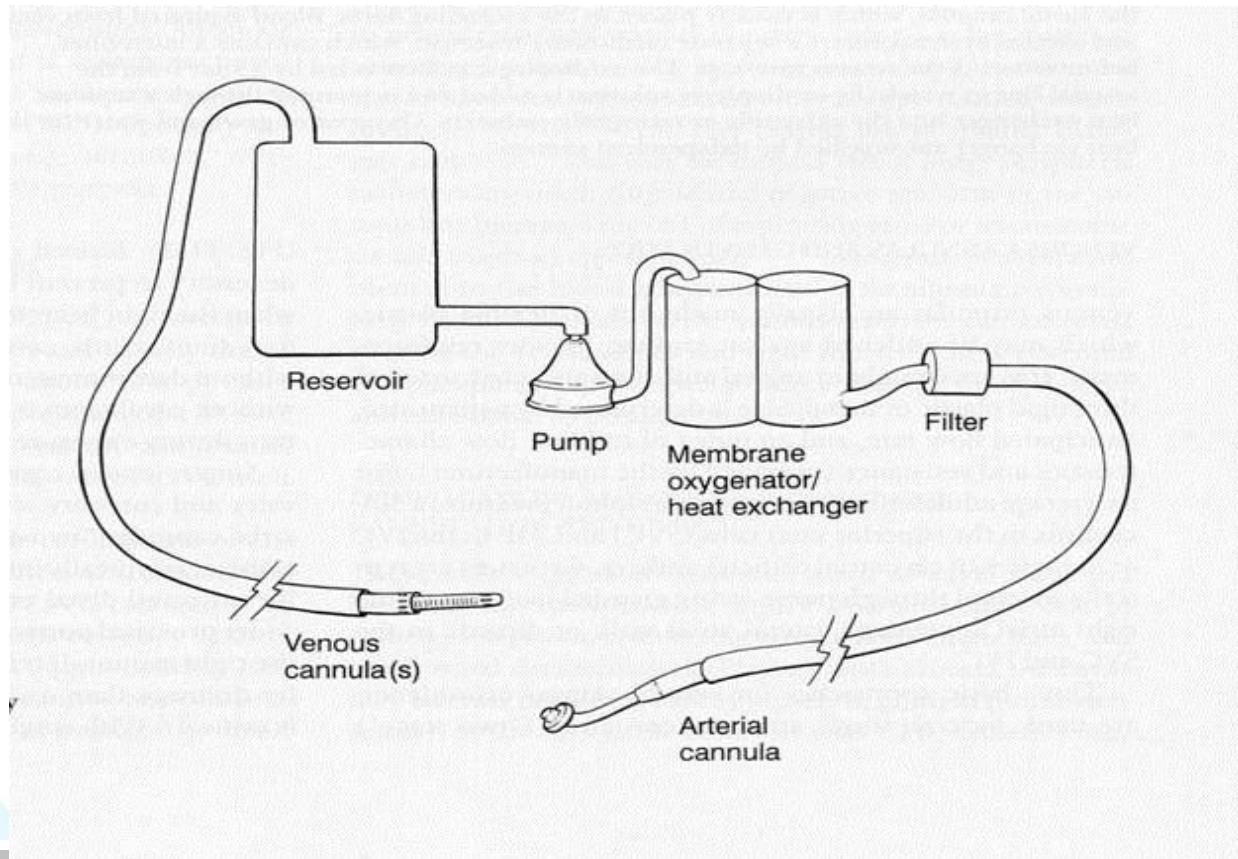
- ECMO : ExtraCorporeal Membrane Oxygenator
- VAD: Ventricluar Assist Device

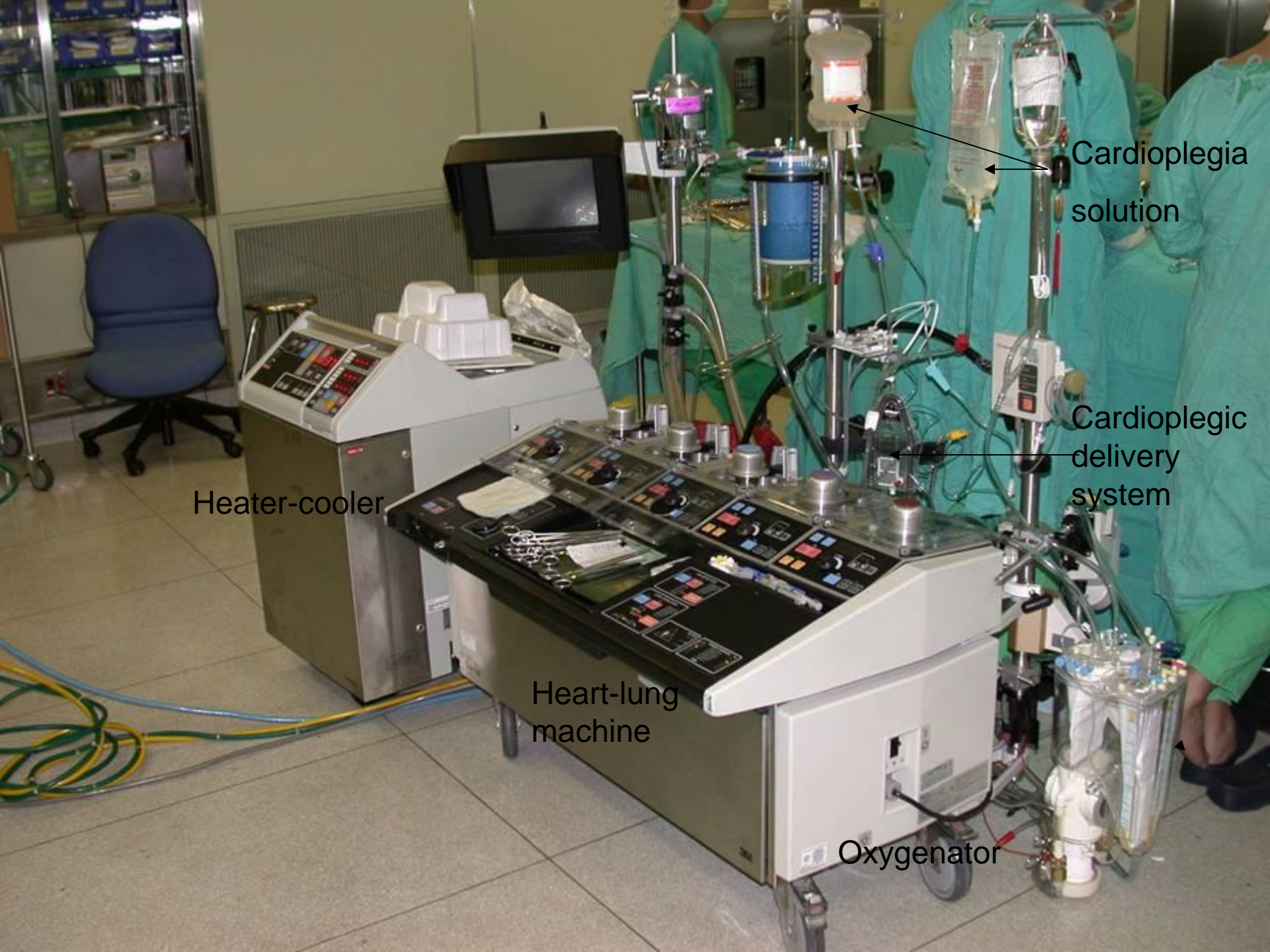


體外循環



Basic cardiopulmonary bypass circuit





Heater-cooler

Heart-lung machine

Oxygenator

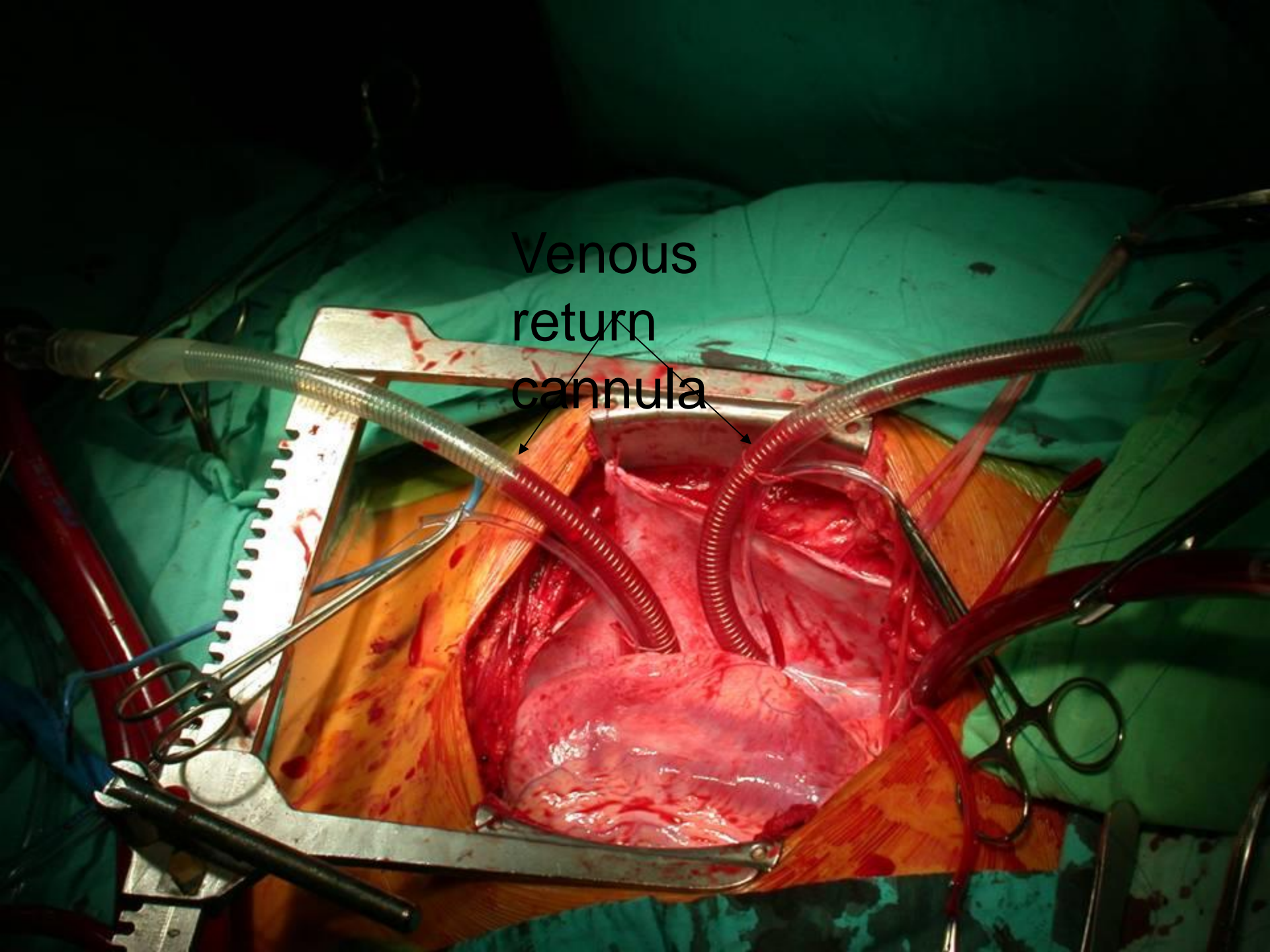
Cardioplegia solution

Cardioplegic delivery system



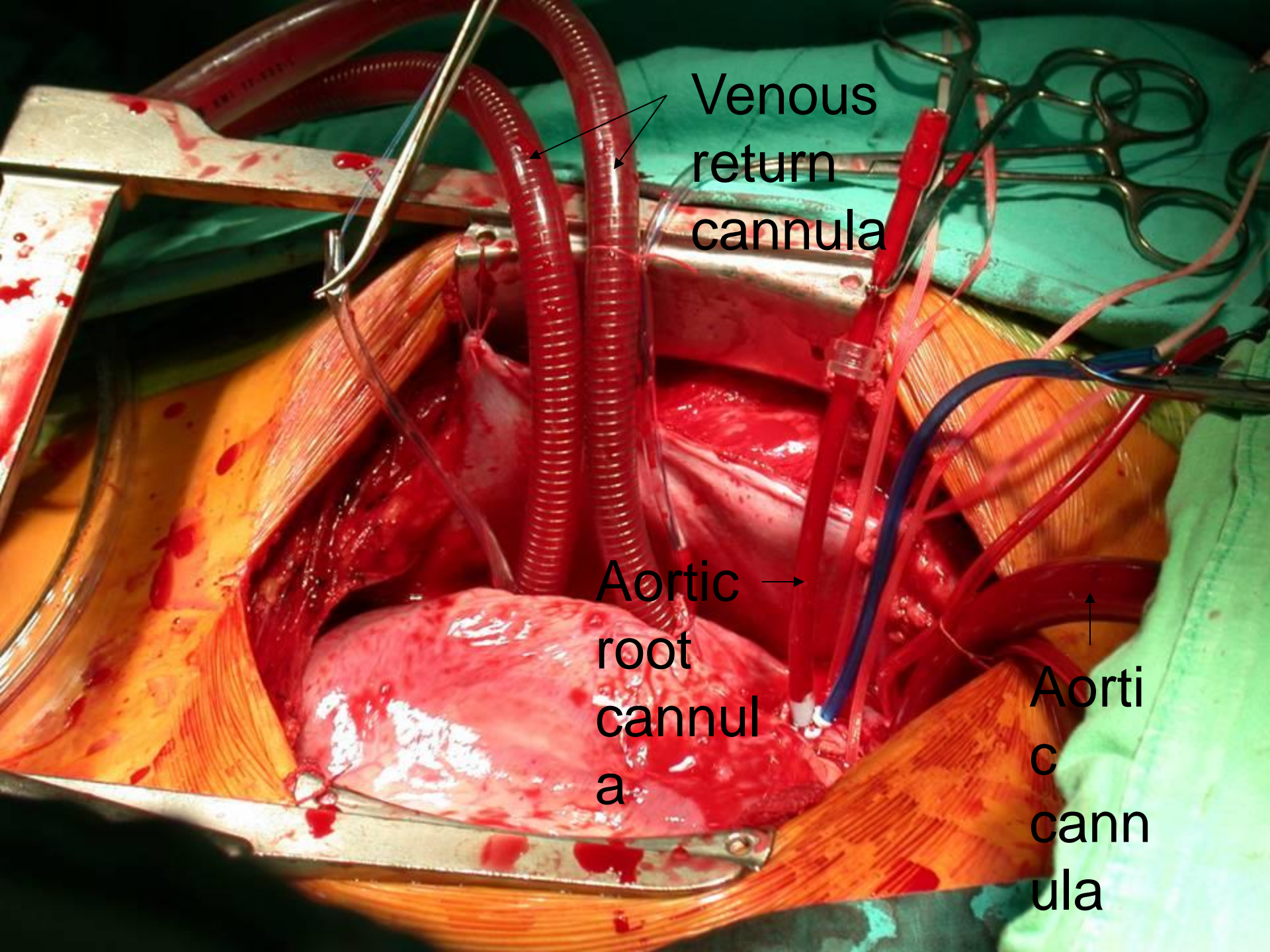
Two stage venous
return cannula

Venous
return
cannula





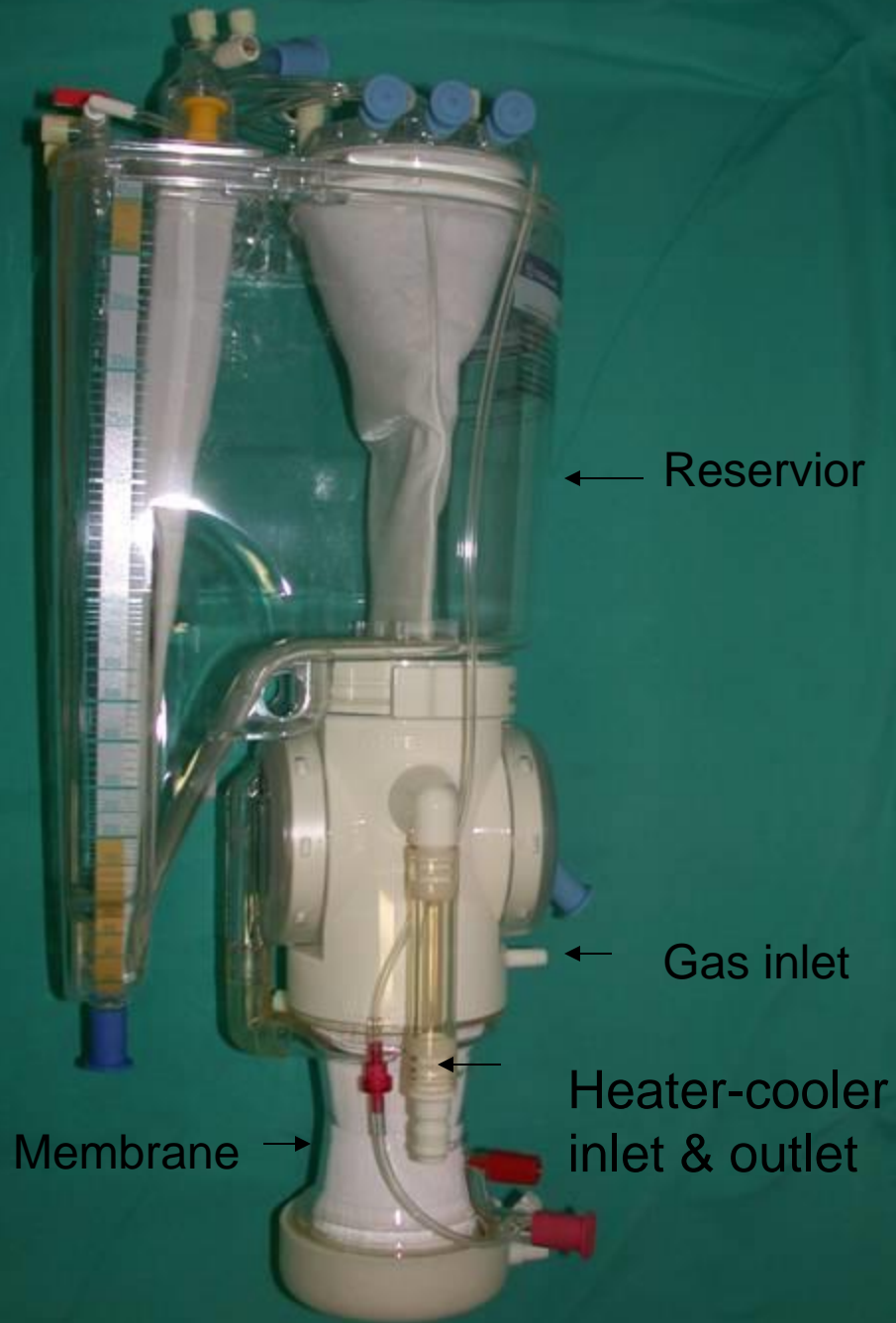
Aortic
cannula



Venous
return
cannula

Aortic →
root
cannul
a

↑
Aorti
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cann
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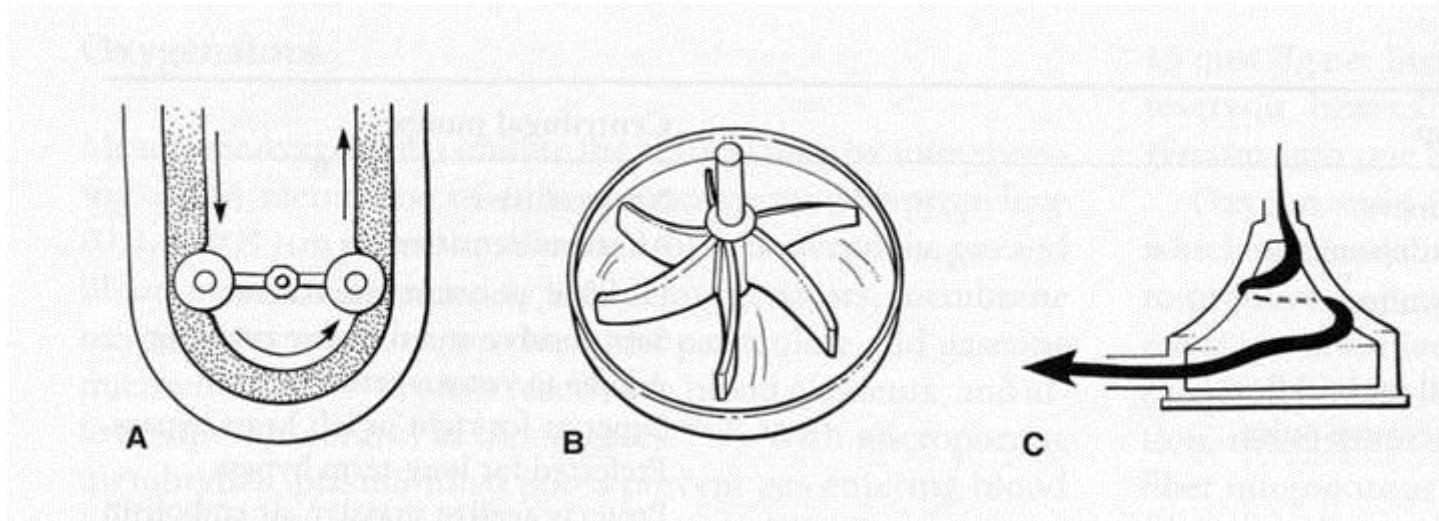


Heater-cooler





Pumps



◆ Roller pump

◆ Centrifugal pump



Arterial
filter

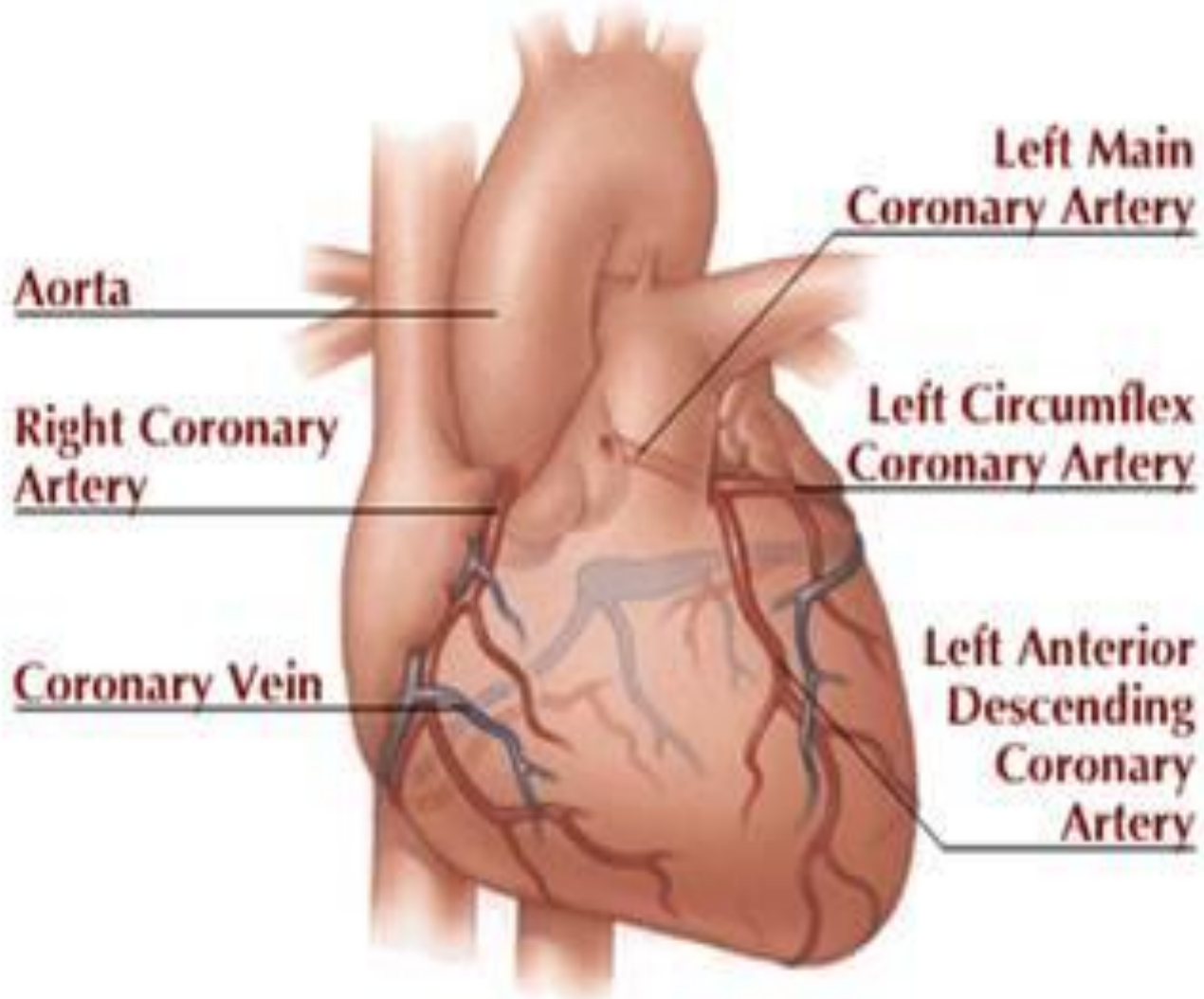




Venting catheter



Coronary Artery Anatomy



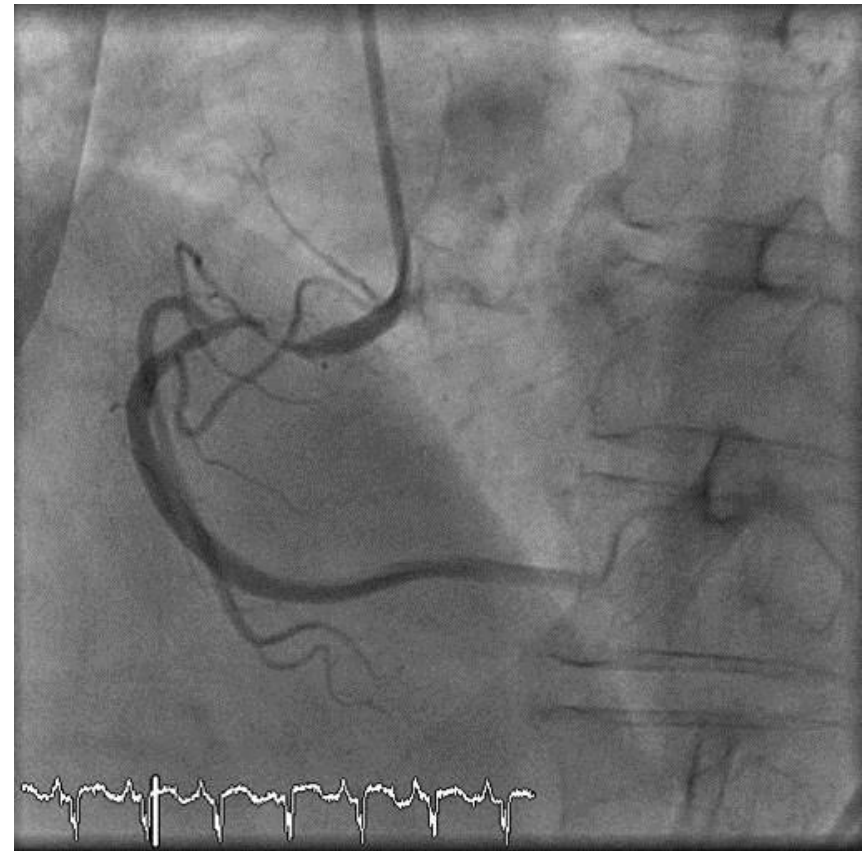
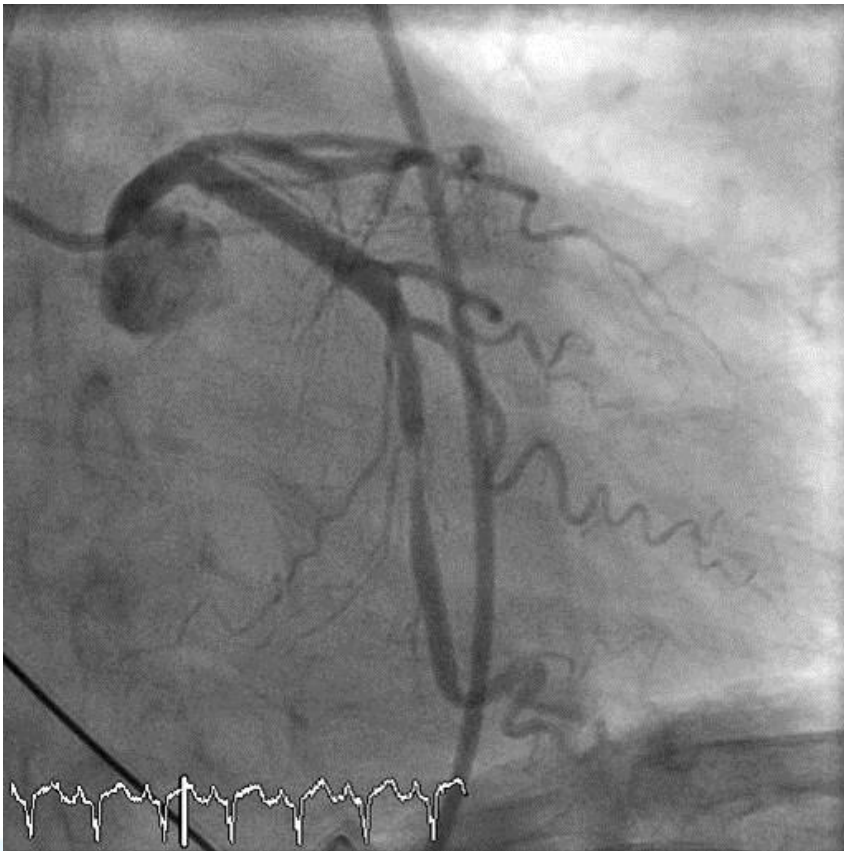


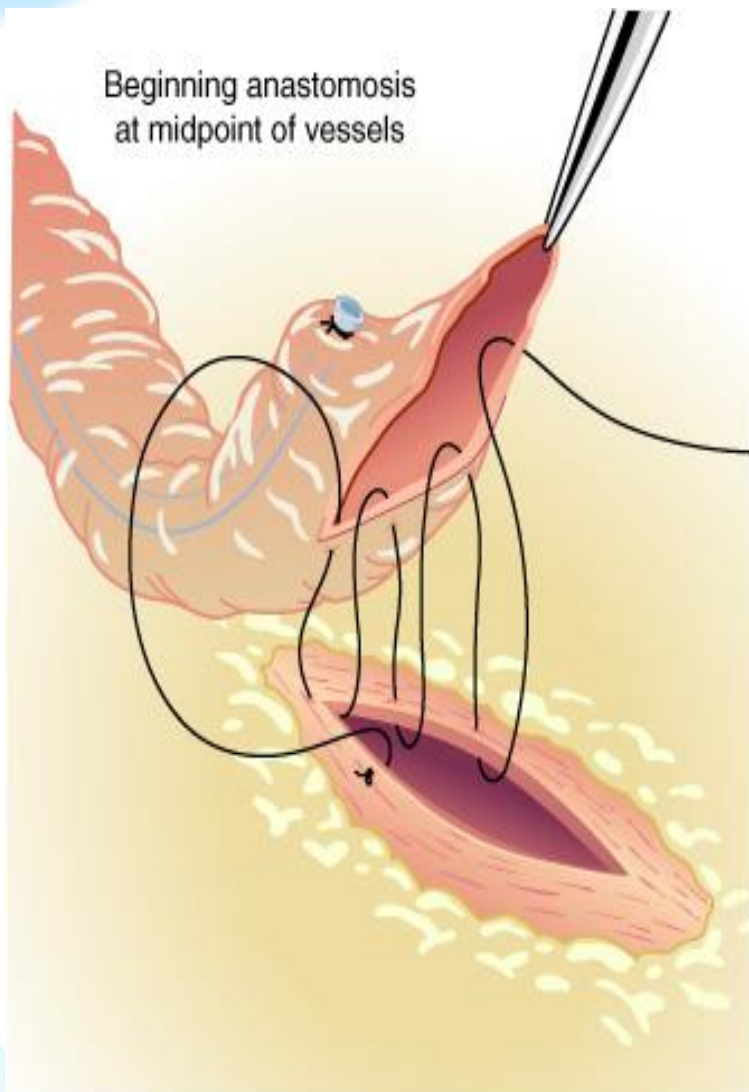
繞道所用之血管

- 下肢大隱靜脈 (saphenous vein): 十年通暢率40-60%。
- 內乳動脈 (internal mammary artery): 通常接左前降支，十年通暢率大於90%。
- 其他
 - 橈動脈 (radial artery)
 - 胃網膜動脈 (gastroepiploic artery)

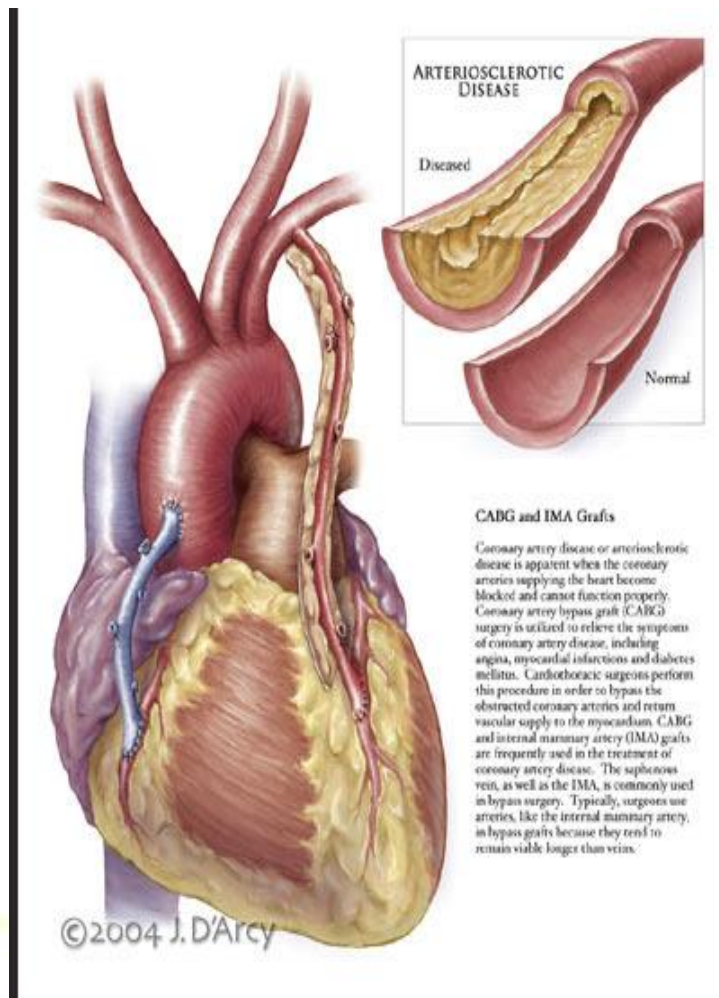


Coronary Angiogram





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CABG and IMA grafts for arteriosclerotic disease

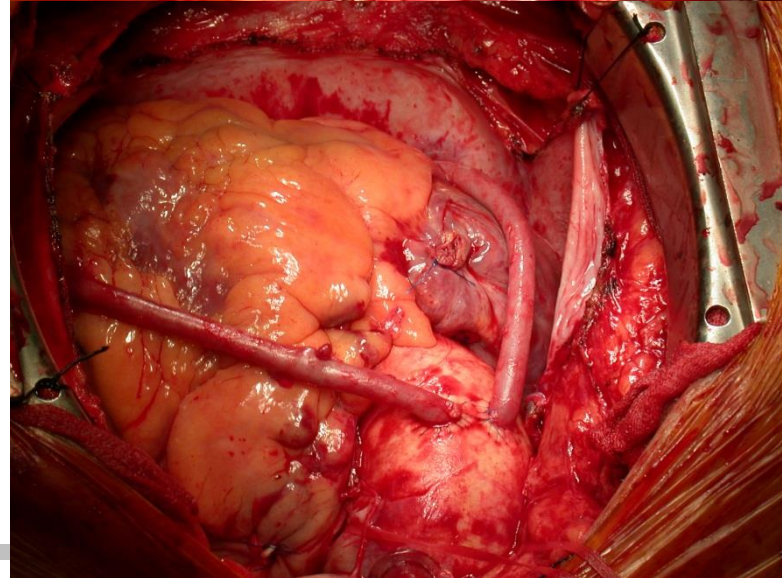
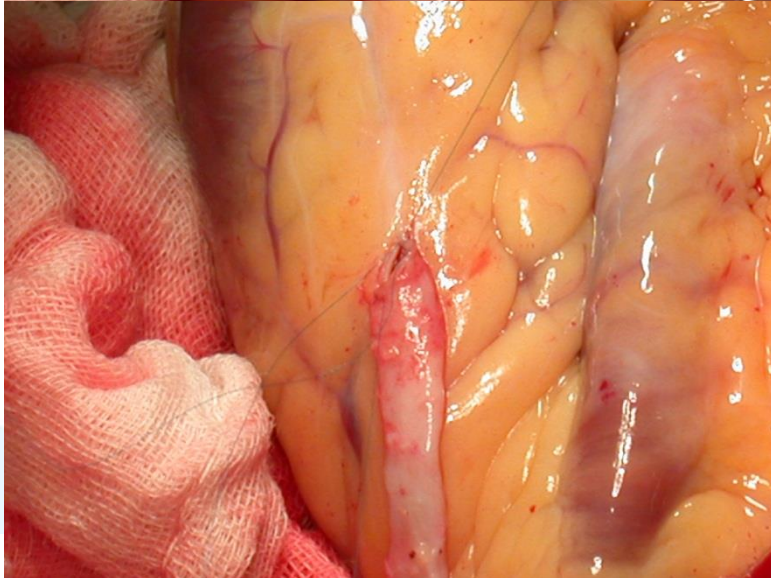
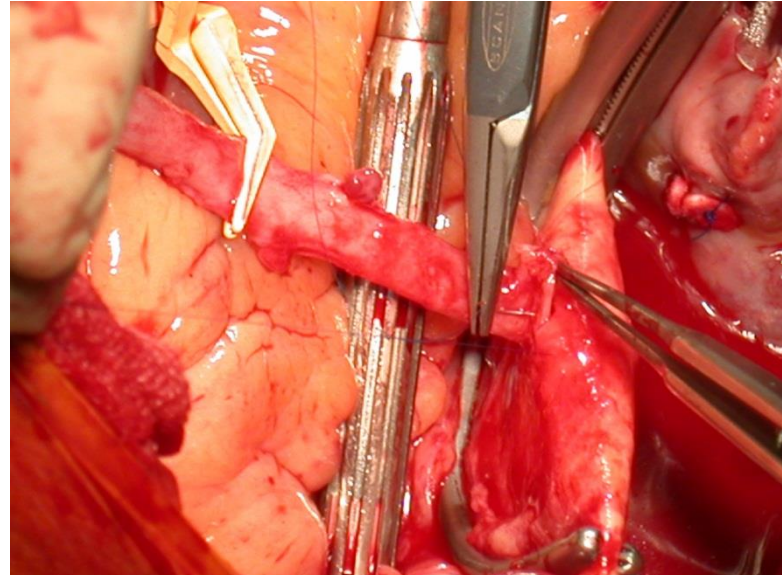
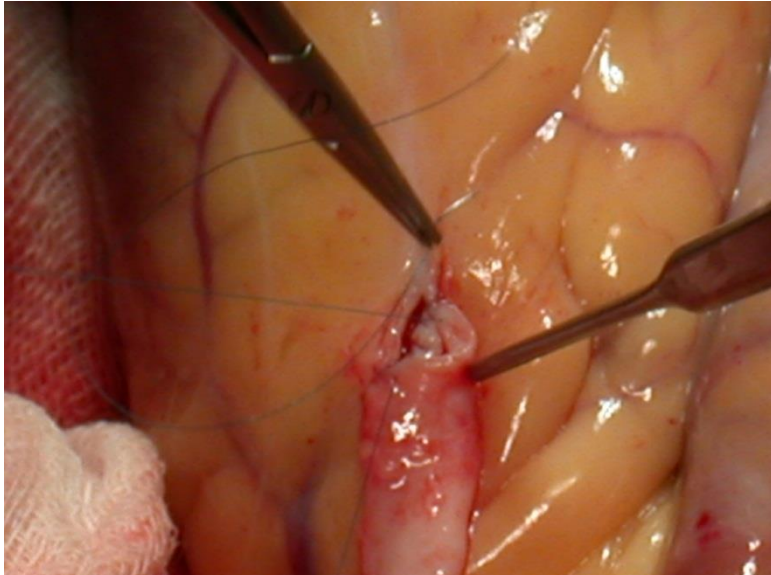
全三總

全新服務
Our Heart,
Our Services!

Tri-Service General Hospital



CABG



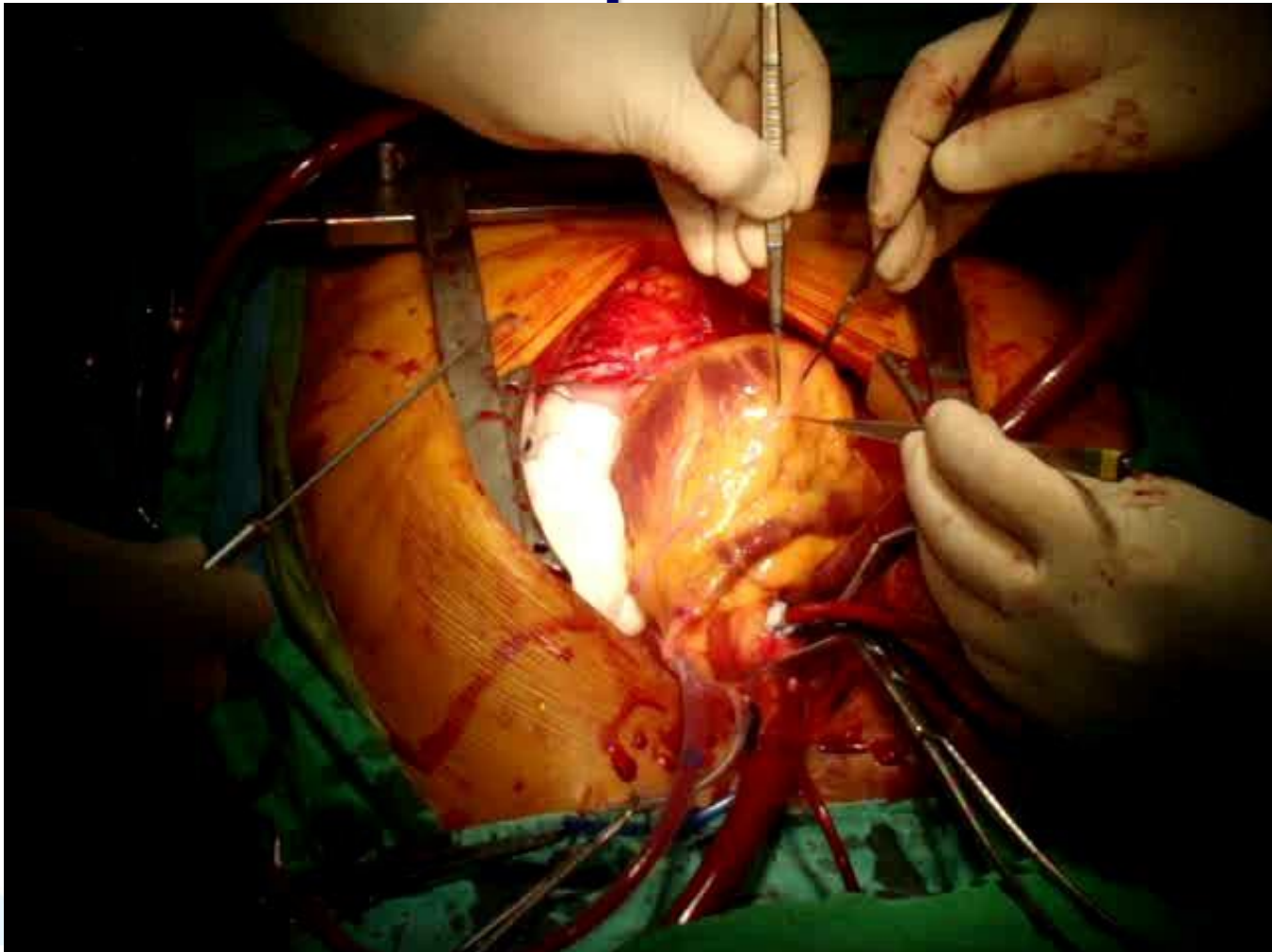


CABG

- **Off-pump CABG**
- **Beating CABG**
- **On-Pump beating CABG**
- **Robot-assisted CABG**



傳統冠狀動脈繞道手術 On Pump CABG





三軍總醫院 *Tri-Service General Hospital*

Beating Heart CABG

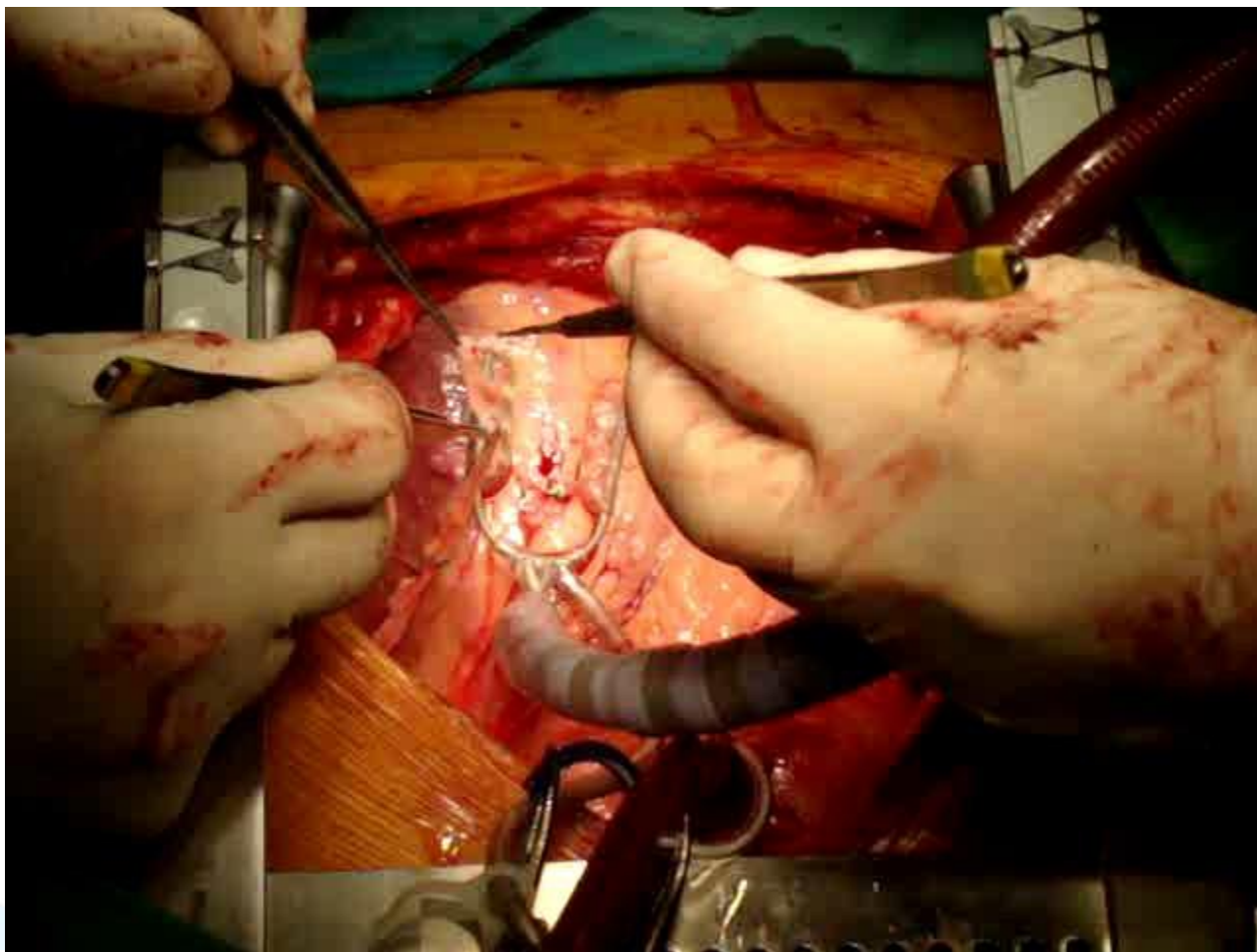
跳動式冠狀動脈繞道手術





On Pump Beating CABG

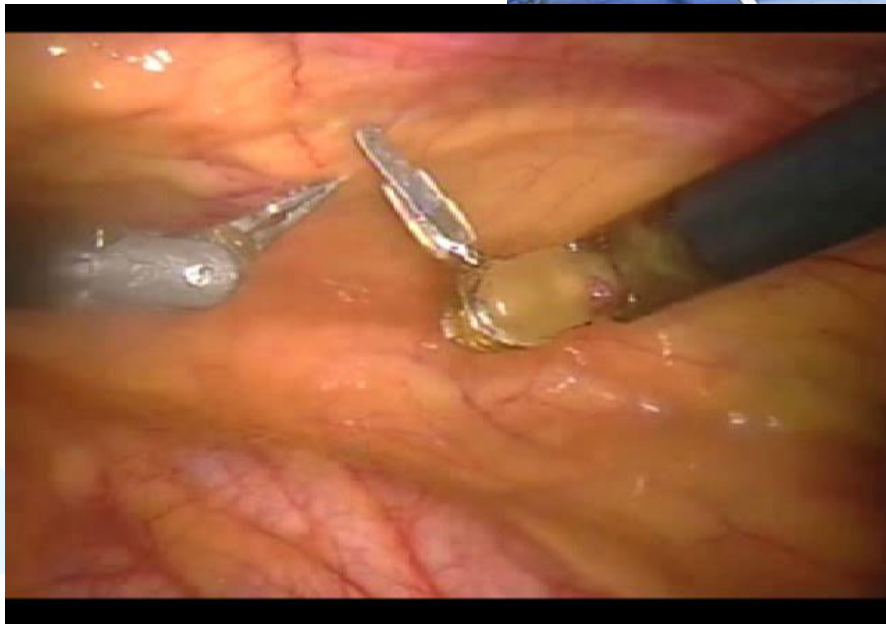
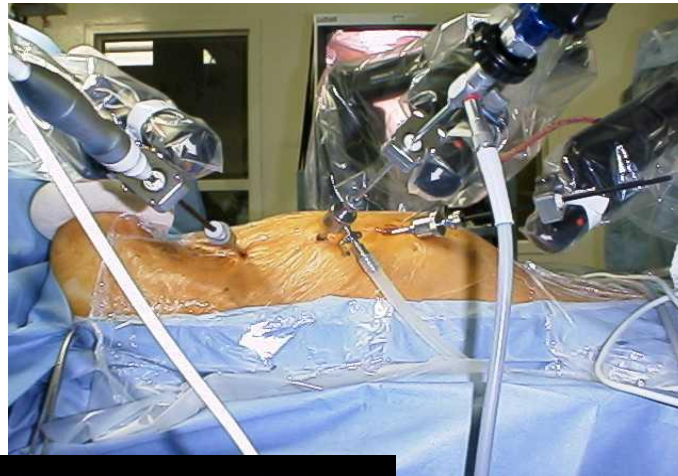
跳動式冠狀動脈繞道手術





Robotic-Assisted Open Heart Surgery

機器手臂輔助微創開心手術



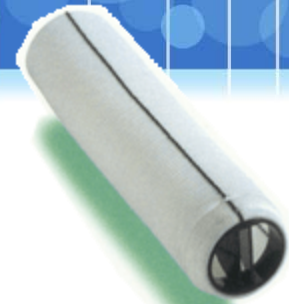


瓣膜手術



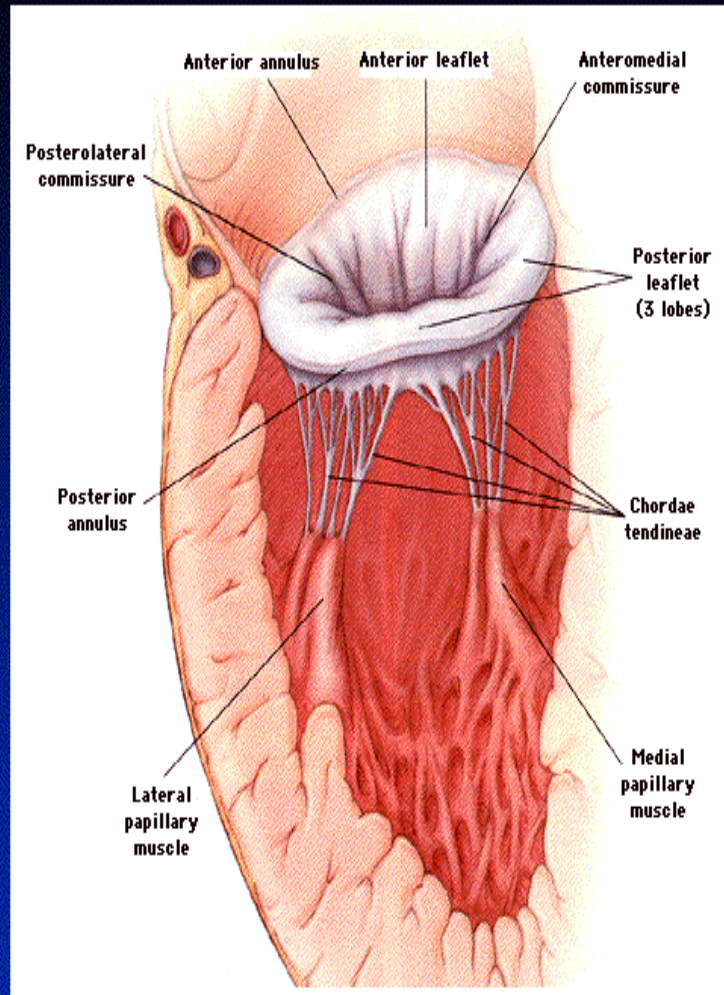
瓣膜置換的選擇

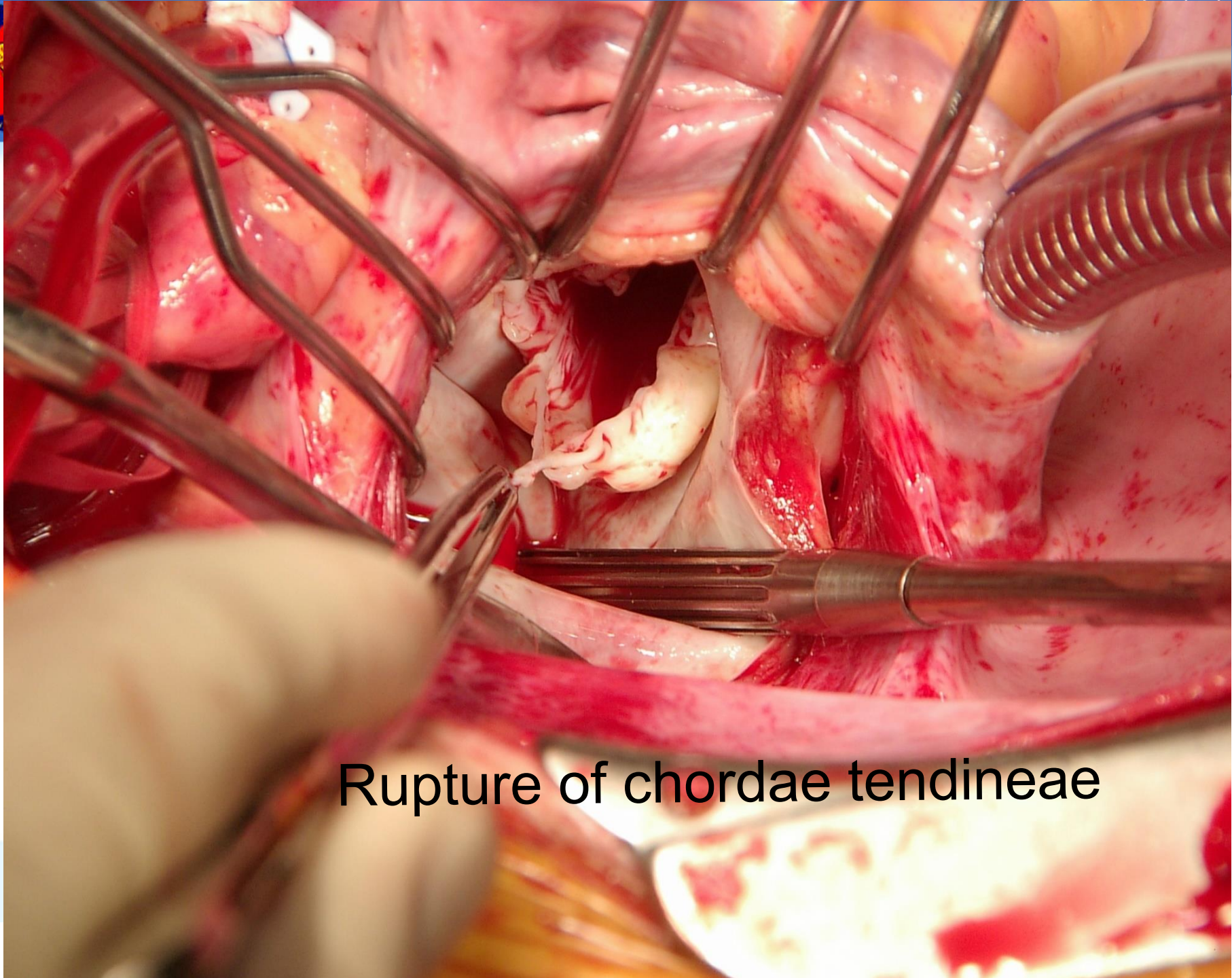
- 心臟的人工瓣膜分成機械性與生物性。
- 機械性的好處是耐用，但易造成血球的磨損而須終生服用抗凝血劑 (Coumadin, Cofarin, Wafarin)，易造成凝血異常故須定期抽血檢驗PT。
- Coumadin有致畸胎的副作用，故不合適用於育齡婦女。
- 生物性瓣膜的好處是不需服用抗凝血劑。





Mitral regurgitation





Rupture of chordae tendineae



心臟移植



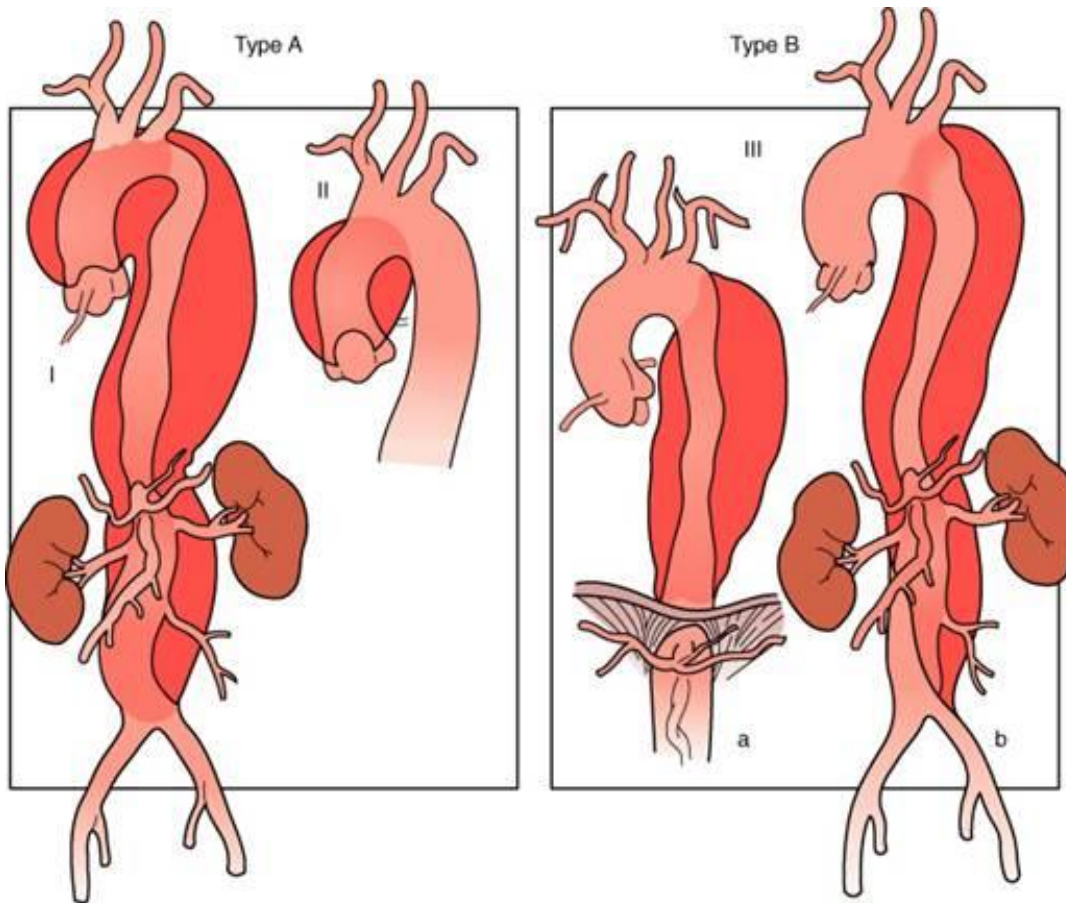


大血管手術

Aortic dissection

Aortic aneurysm

分類

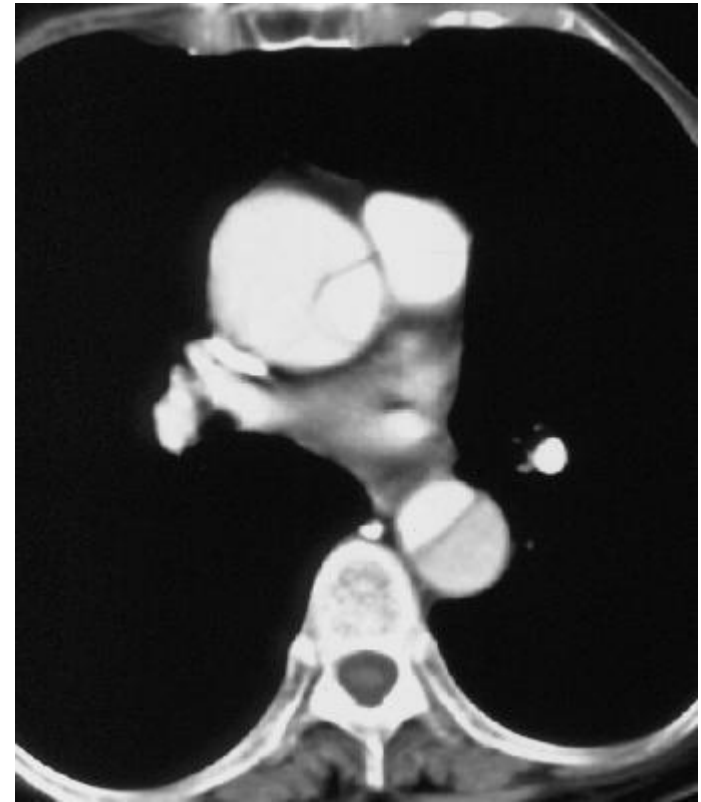


- *Left, Stanford type A, DeBakey types I and II.*
- *Right, Stanford type B, DeBakey type III.*

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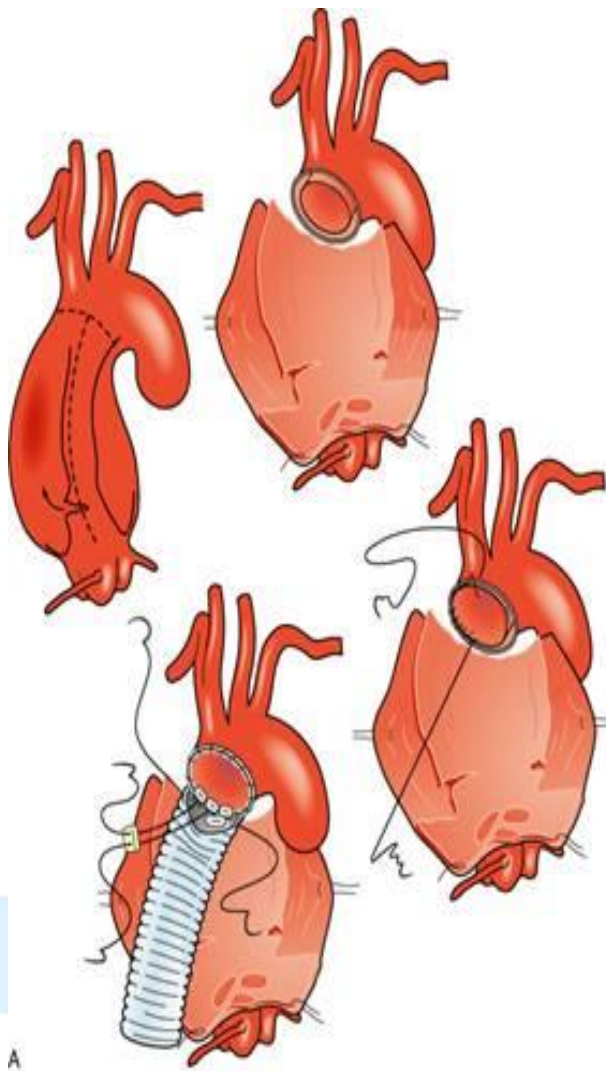


Type A aortic dissection

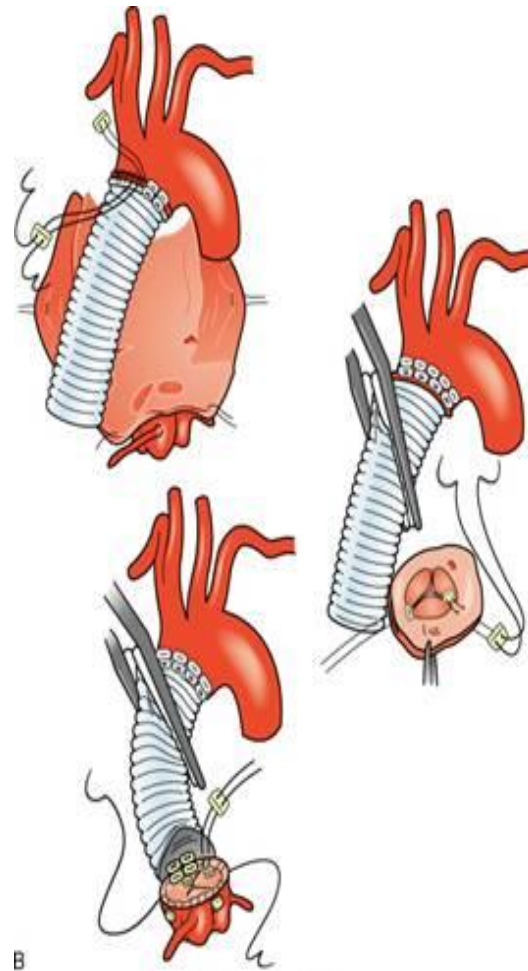




Reconstruction of ascending aorta



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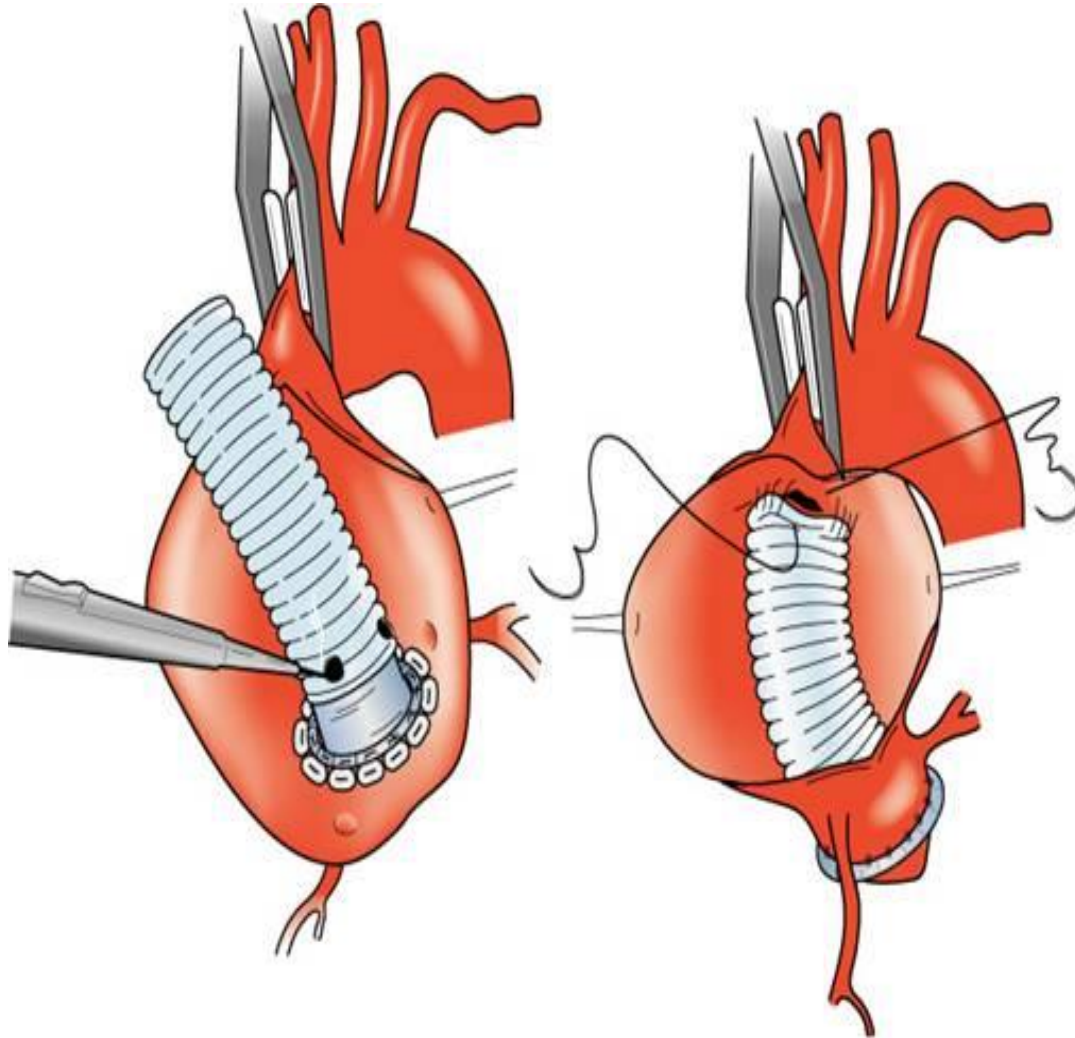


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Bentall Operation



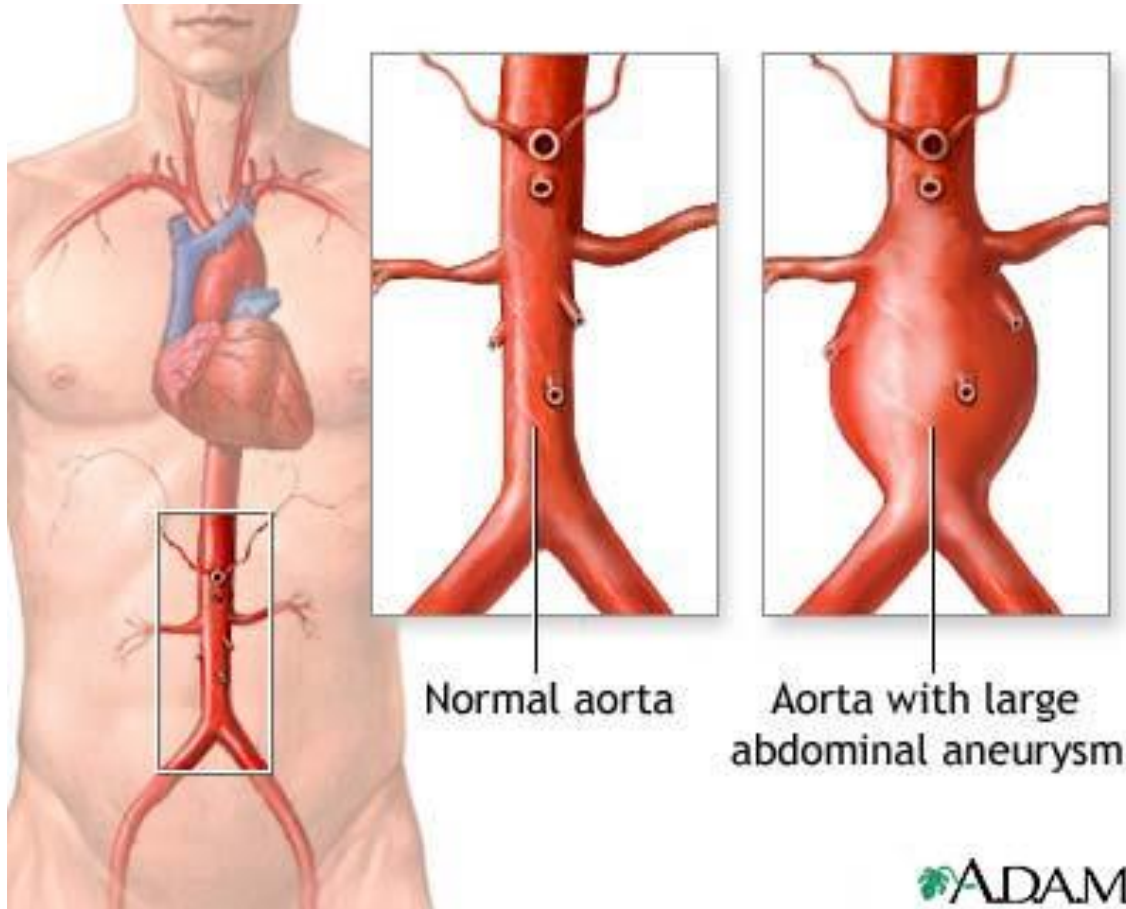
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Abdominal Aortic Aneurysm

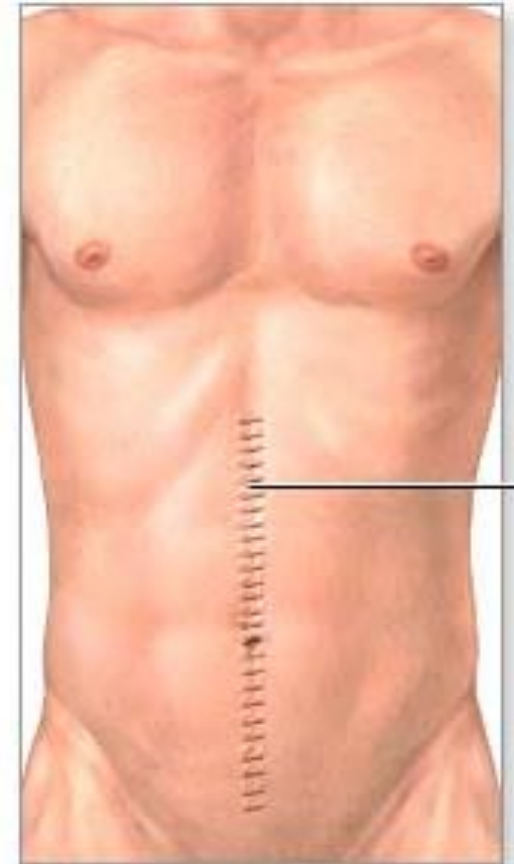
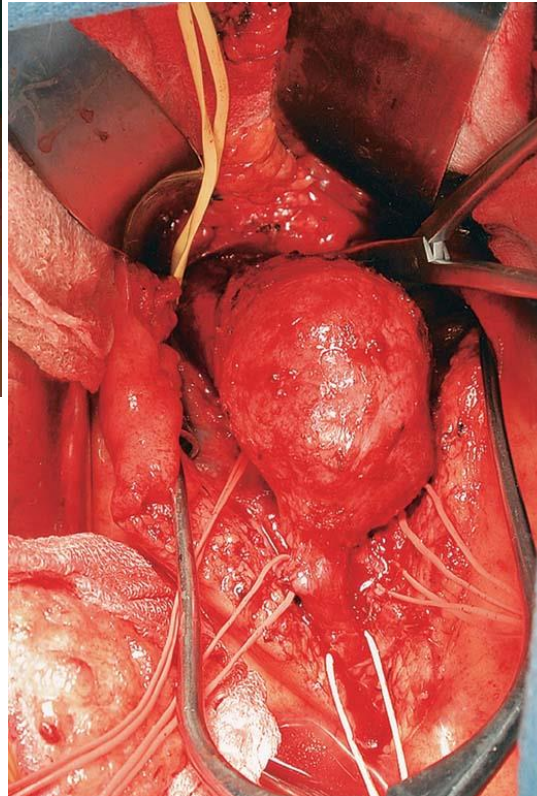
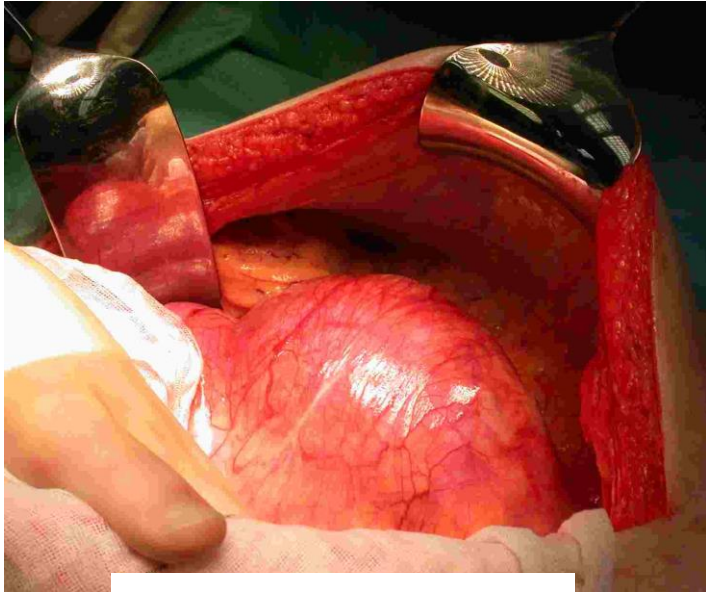


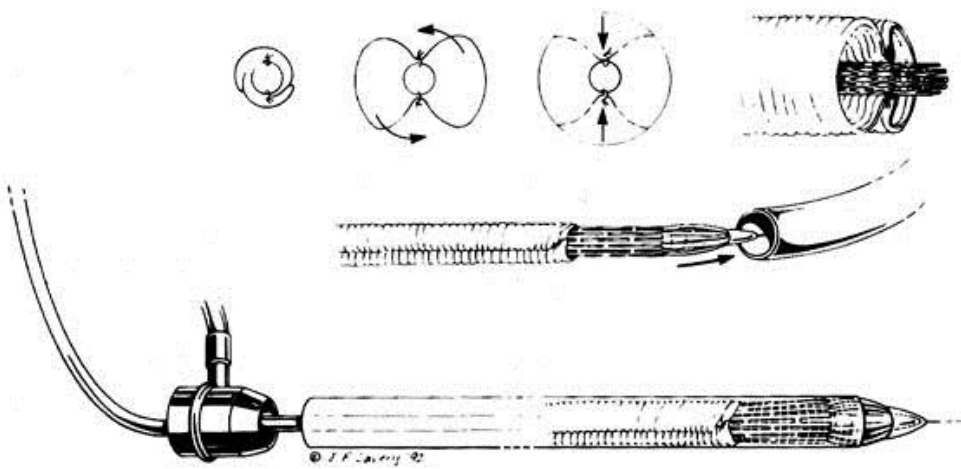
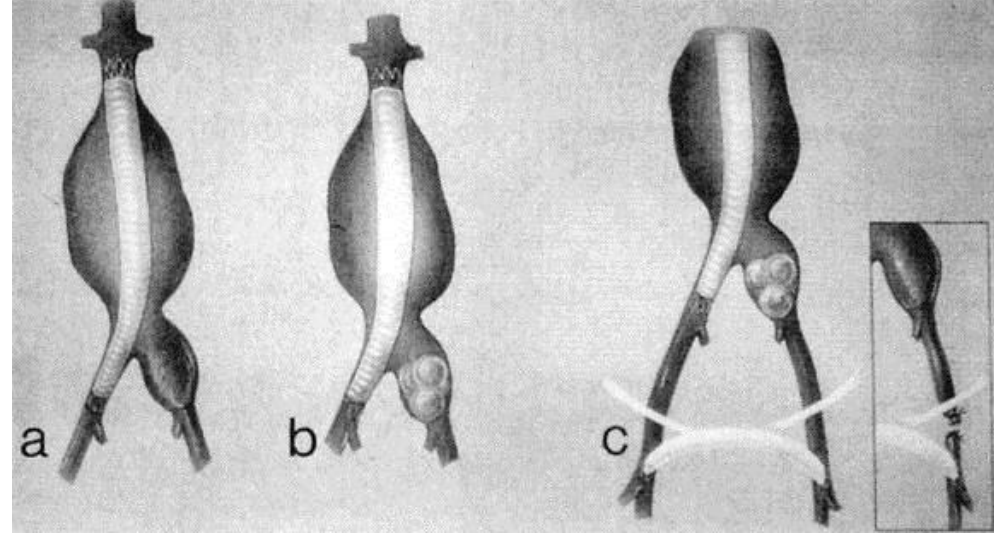
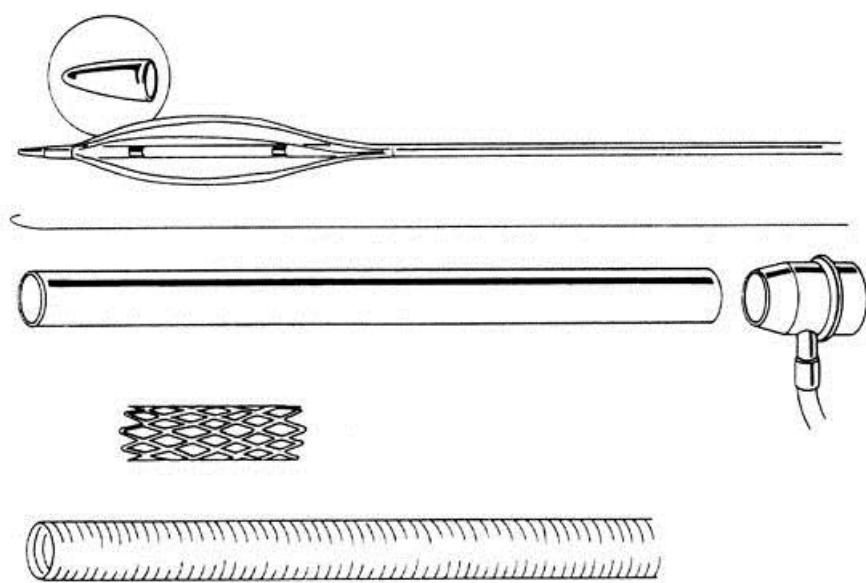
Abdominal aortic aneurysm



ADAM.

Abdominal aortic aneurysm

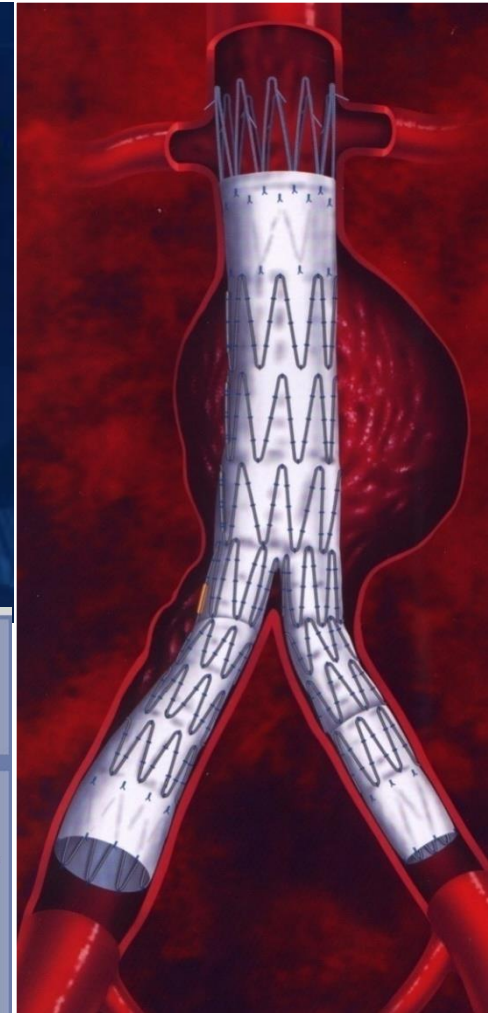
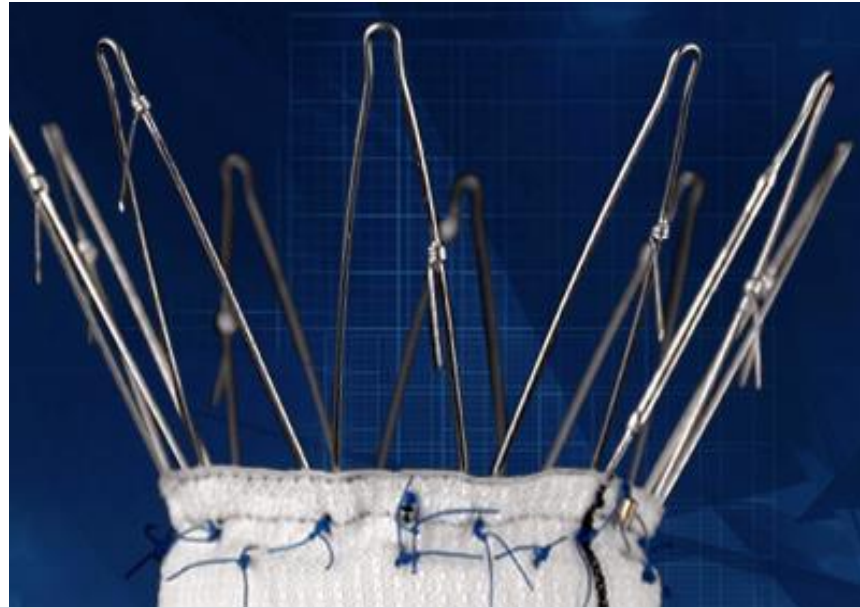
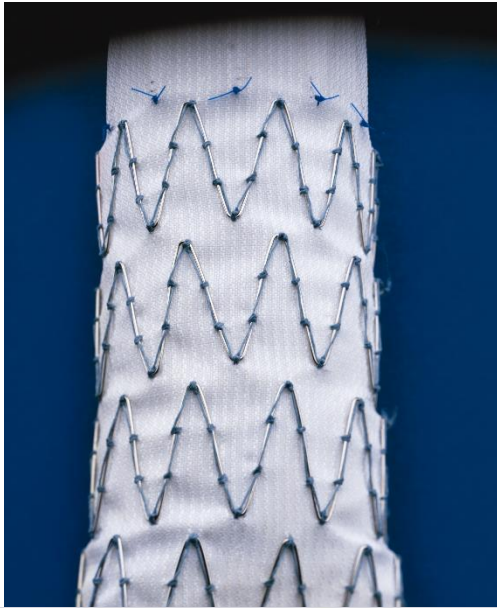











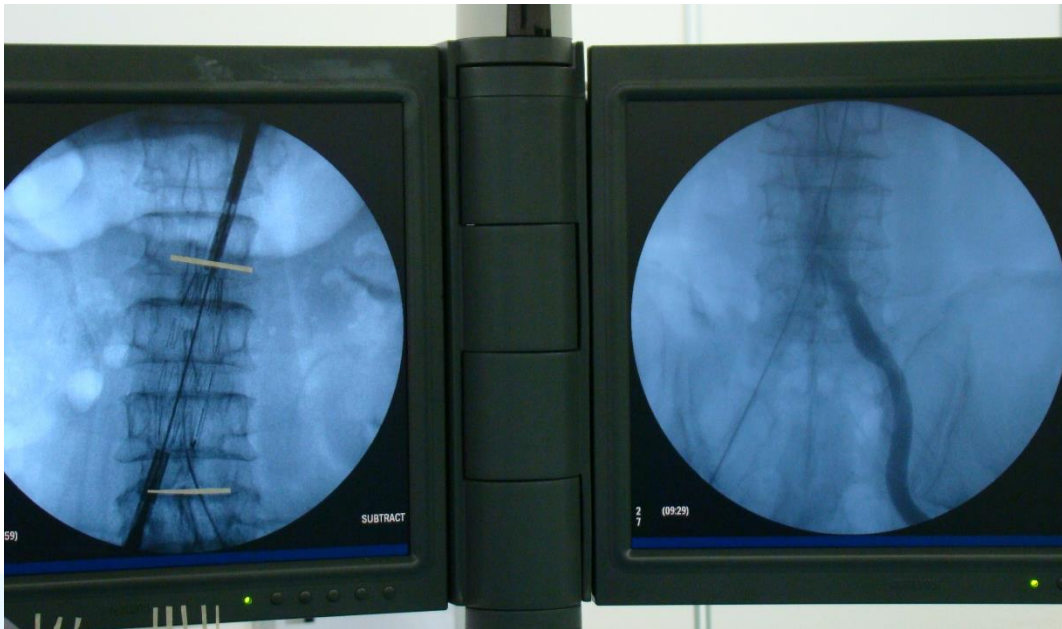
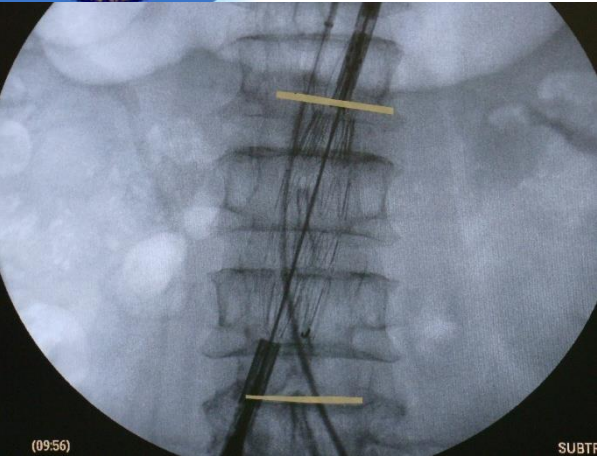
Journal of Vascular Surgery, [Volume 21, Issue 4](#), April 1995, Pages 549–557

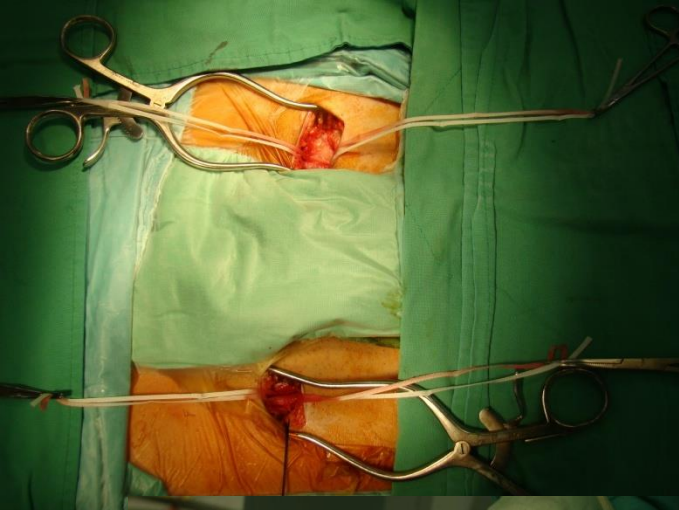


Endovascular aortic reconstruction

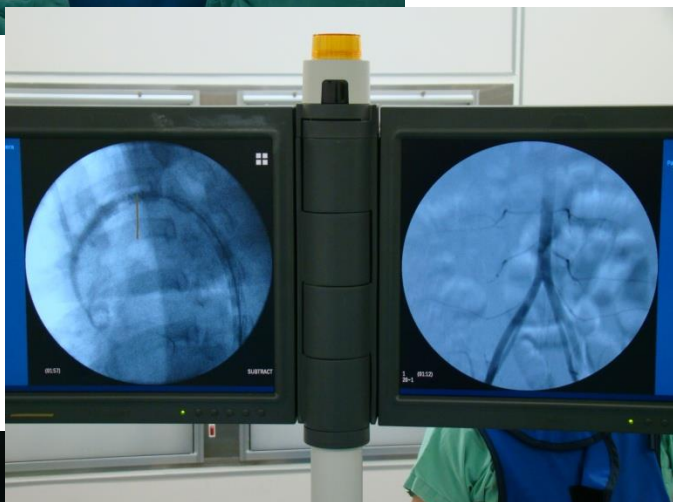
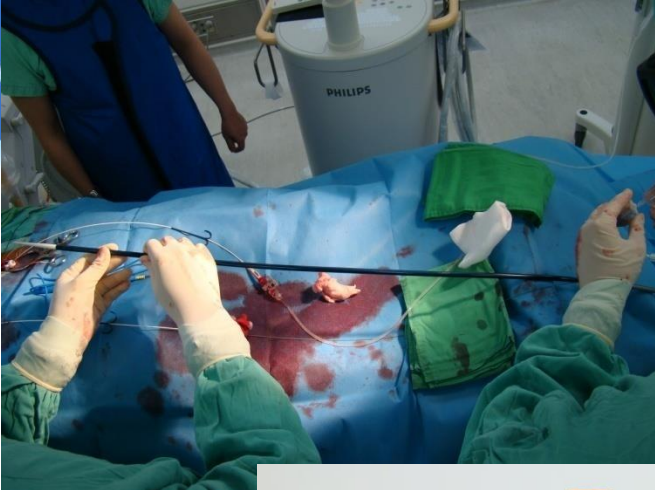


<i>September</i> 1999		<i>November</i> 2002		<i>May</i> 2003		<i>October</i> 2004		<i>April</i> 2008		<i>December</i> 2010	
Ancure Guidant	AneuRx Medtronic	Excluder Gore	Zenith Cook	Powerlink Endologix	Talent Medtronic	Endurant Medtronic					
											





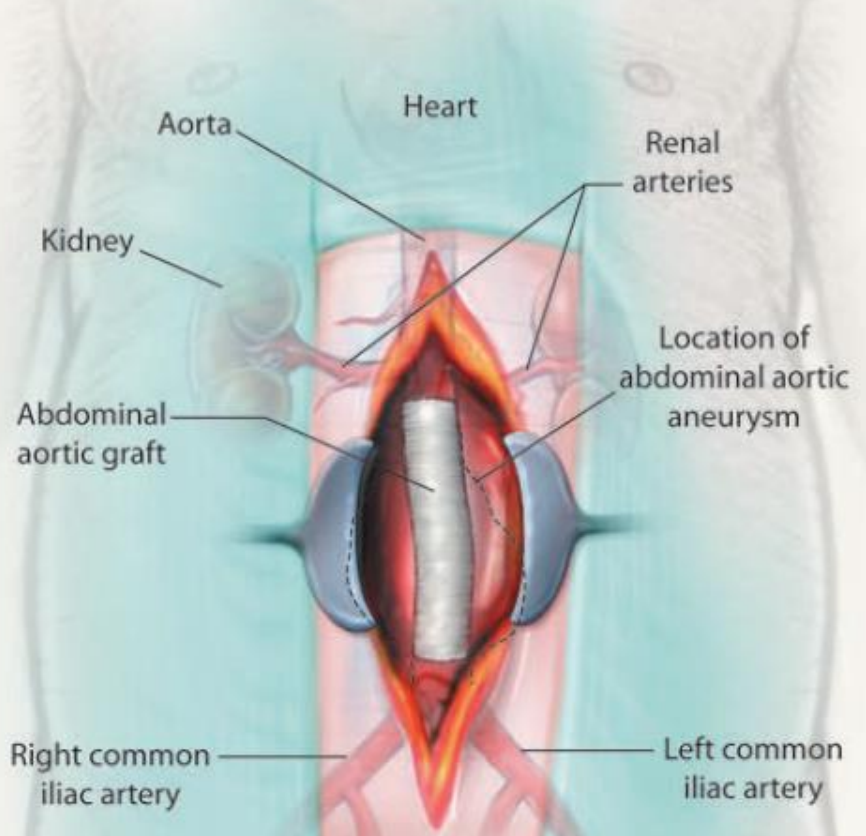
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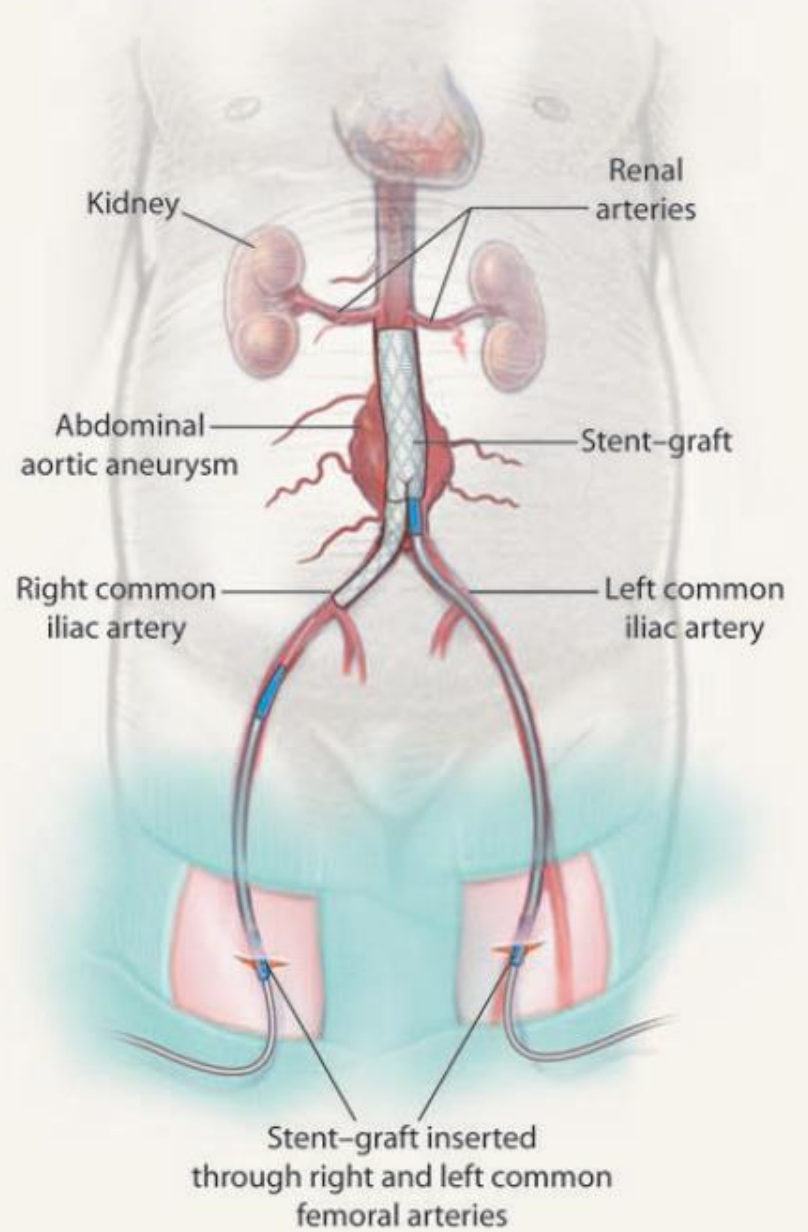
全三總
全新



Open repair of an abdominal aortic aneurysm



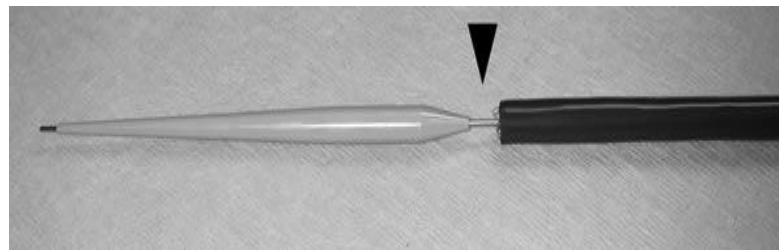
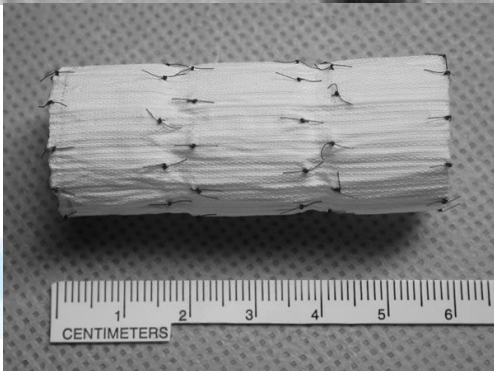
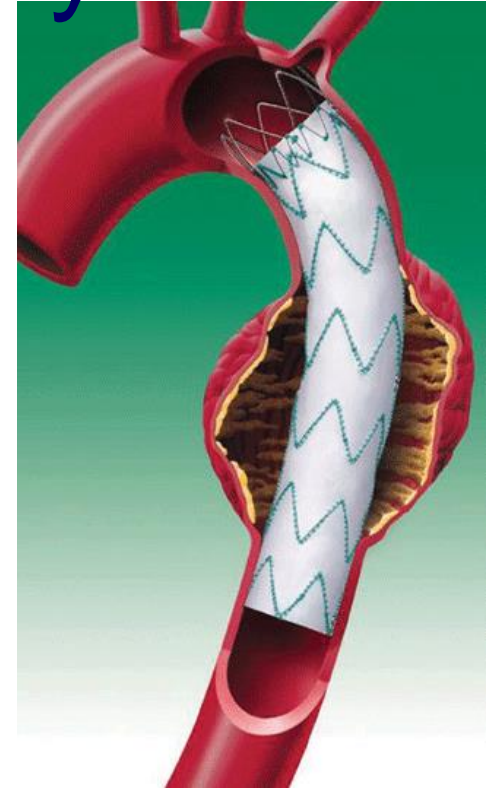
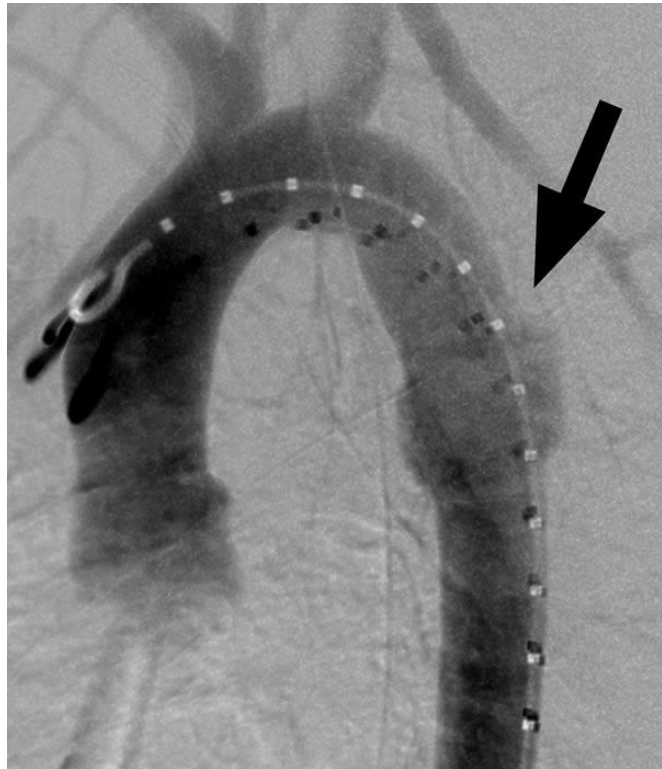
Endovascular repair of an abdominal aortic aneurysm







Thoracic aortic aneurysm

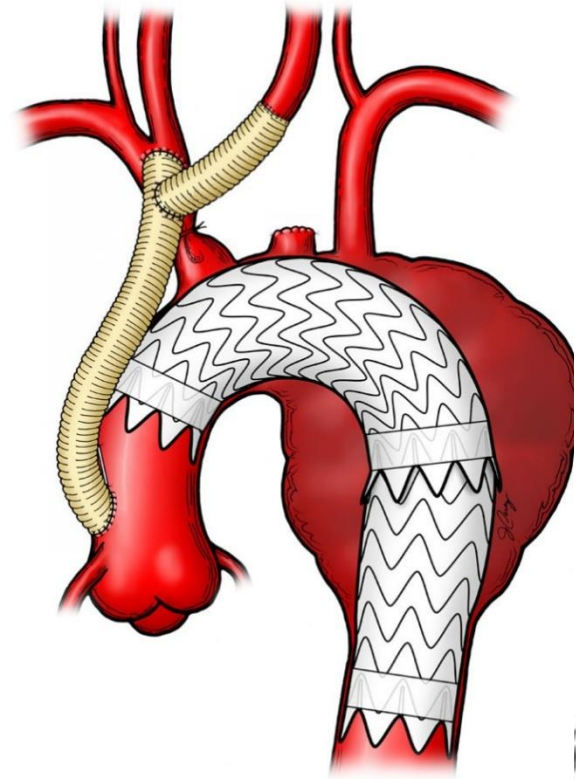




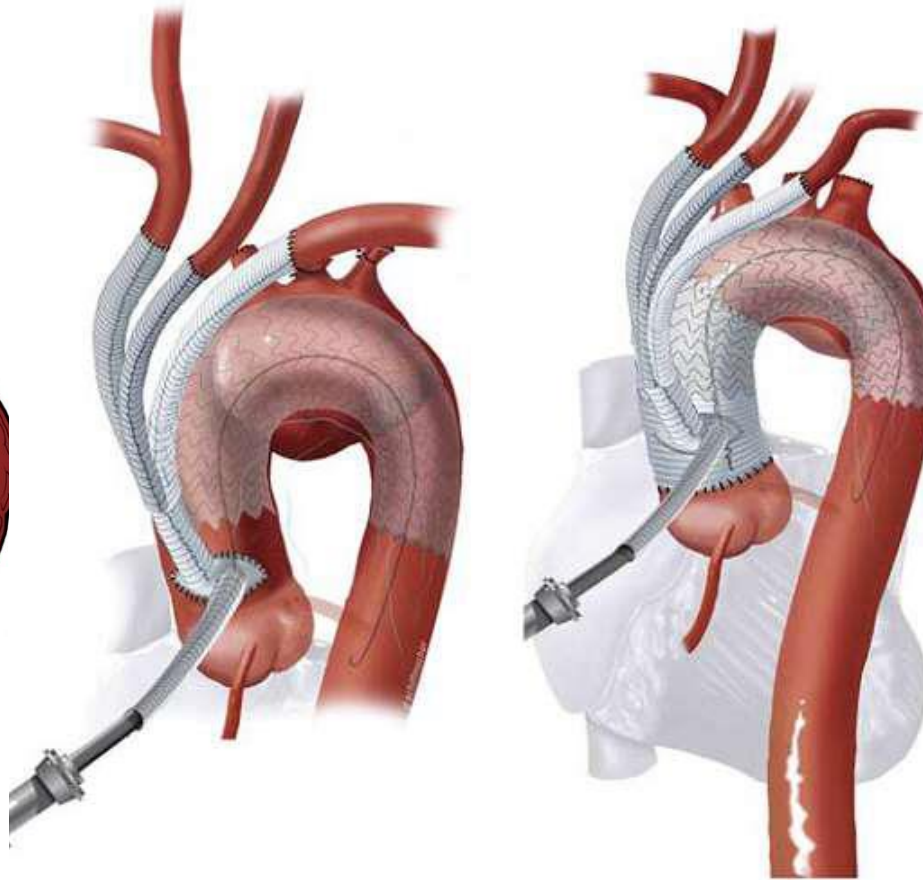
Hybrid Arch Procedure and Concept

"Classic" Debranching

Type I



Type II

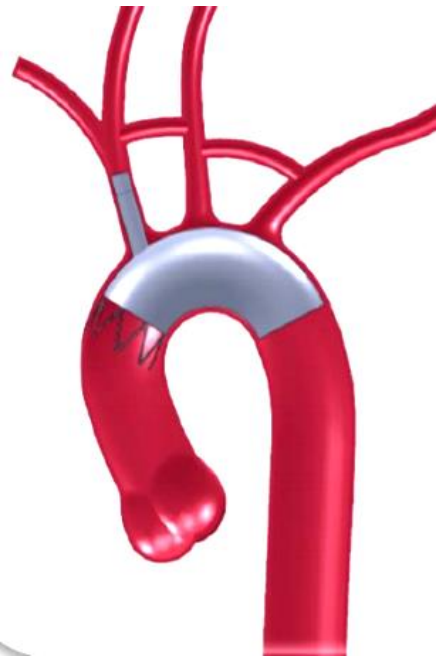


Type III





Aortic arch and chinney



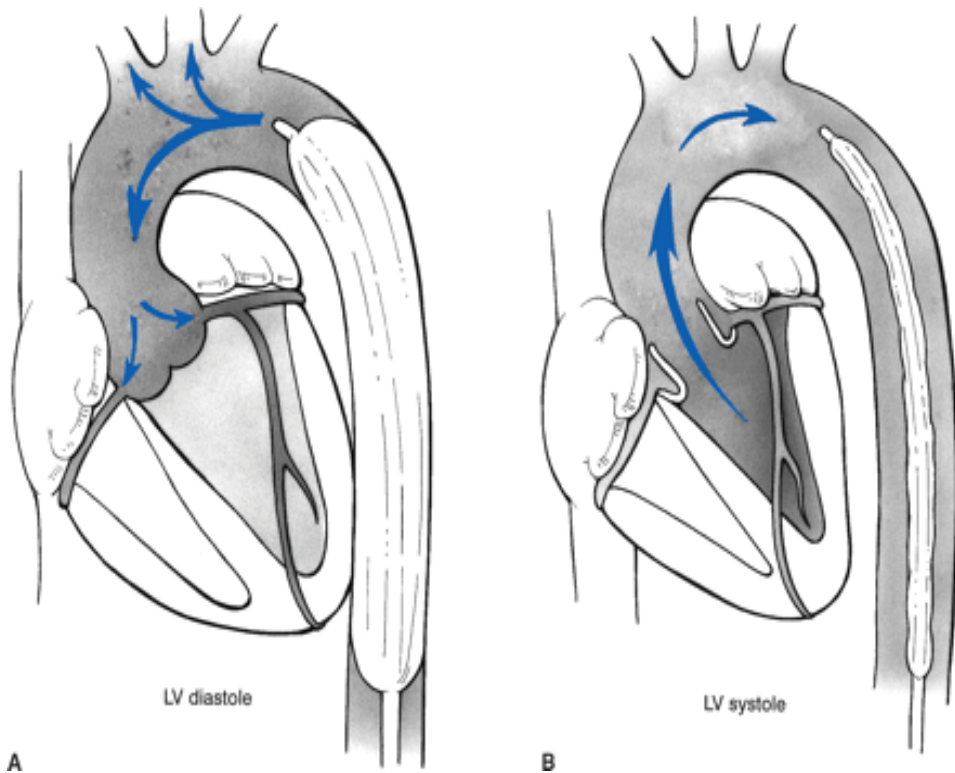


Mechanical Support

Mechanical support:

- IABP, ECMO, VAD(CentriMag device)
- **Earlier implantation** of the device improved survival.

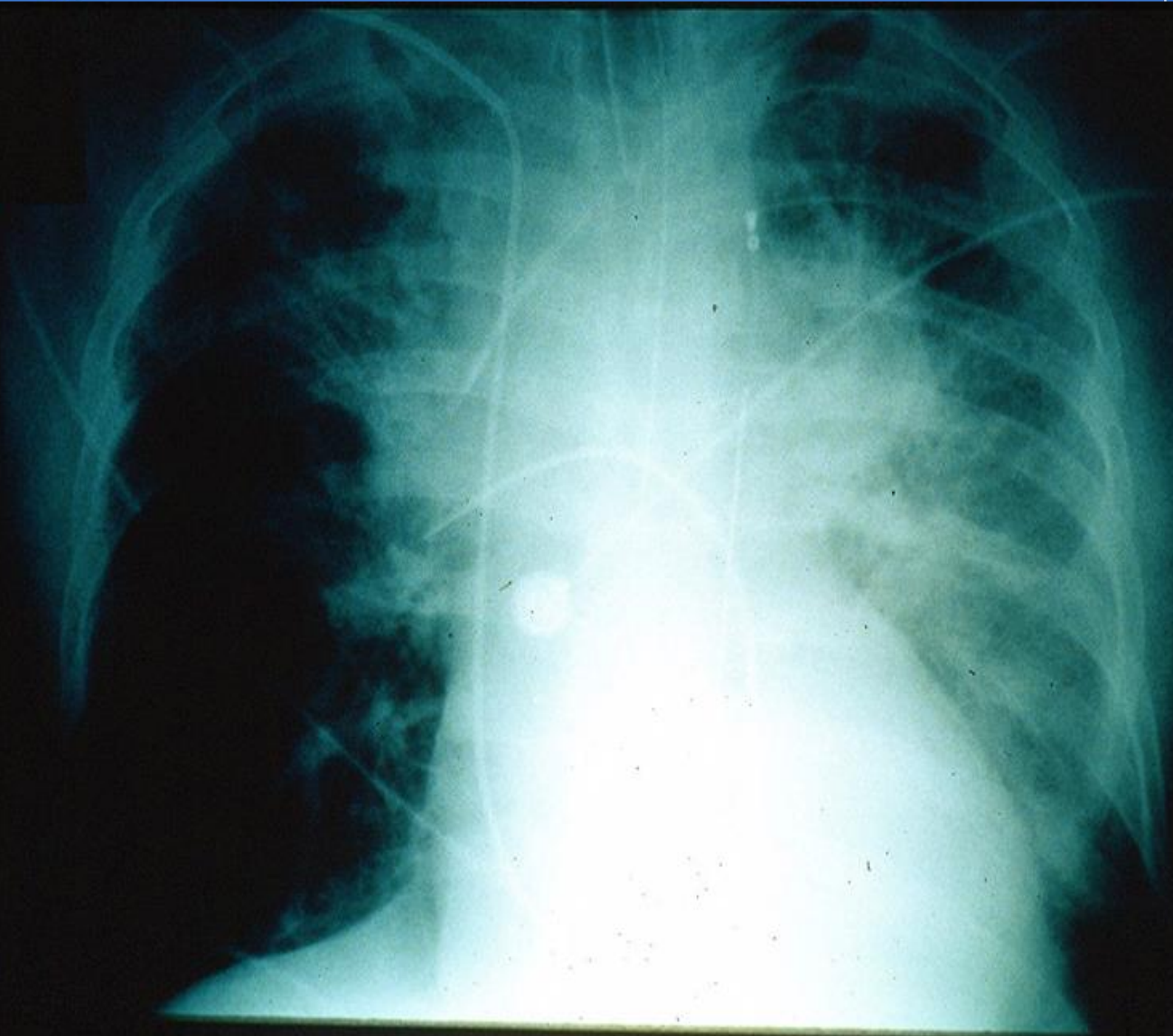
主動脈內汽球幫浦的原理



- 心臟收縮時（Q波出現），氣球塌陷，可以降低心臟的後負荷
- 心臟舒張時（T波出現），氣球膨脹，可以把血液壓回昇主動脈，藉此增加冠狀動脈的灌流

Diastolic
augmentation







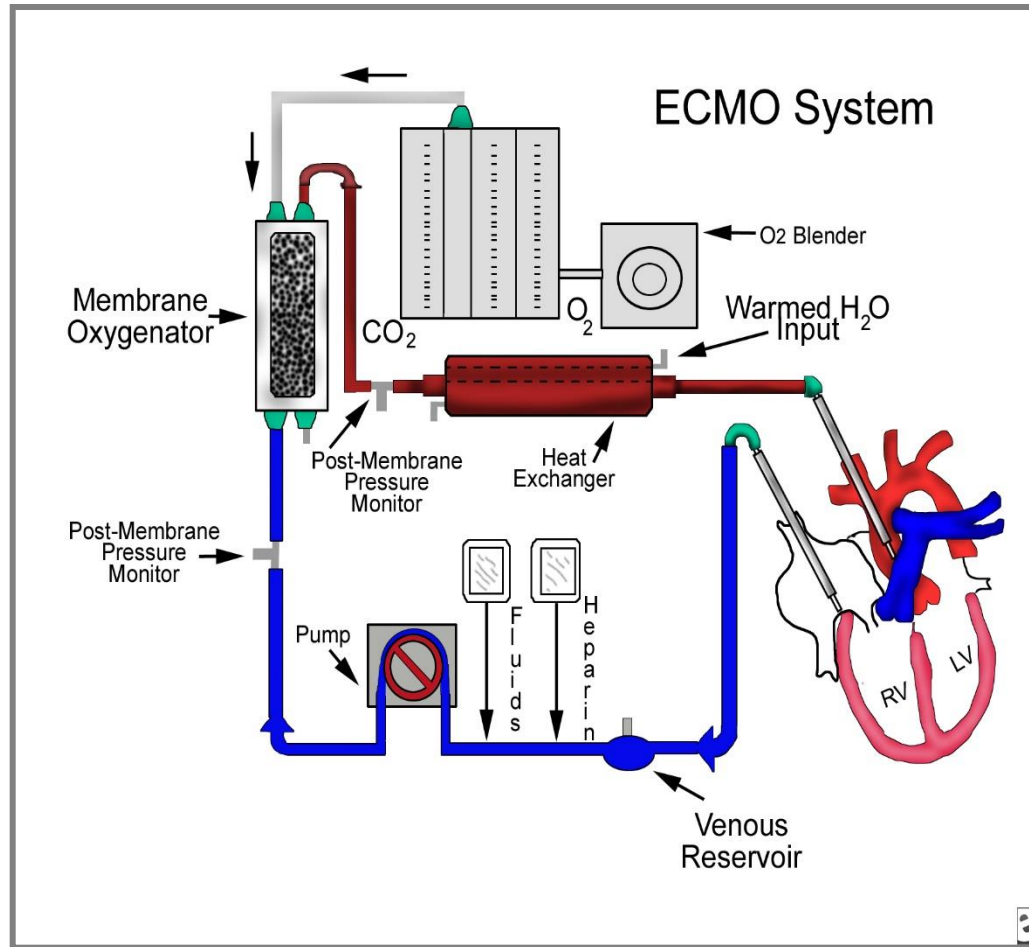
併發症

- 常見合併症：
 1. 氣球破裂或導管折斷。
 2. 動脈破裂。
 3. 動脈剝離。
 4. 血栓、氣栓、栓塞。
 5. 腿部缺血性壞死。
 6. 置入導管之肢體的神經病變。
 7. 感染。



Extracorporeal membrane oxygenation (ECMO)

葉克膜體外氧合系統



Partial CPB







葉克膜體外循環輔助裝置

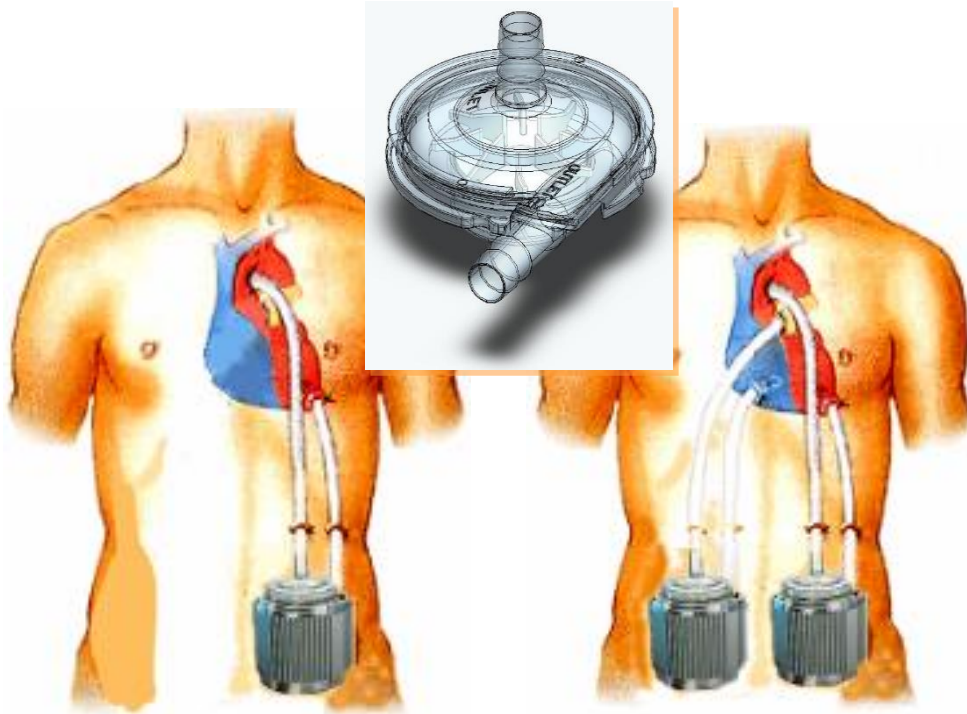


心室輔助器

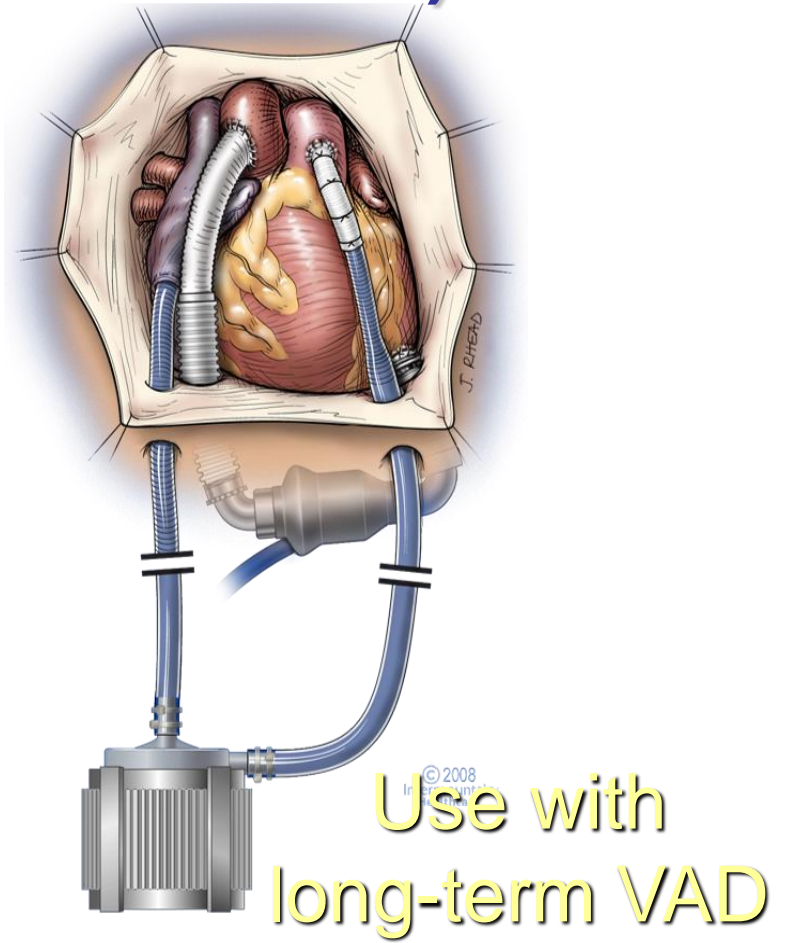




CentriMag® 心室輔助系統 適用範圍 (Indications For Use)



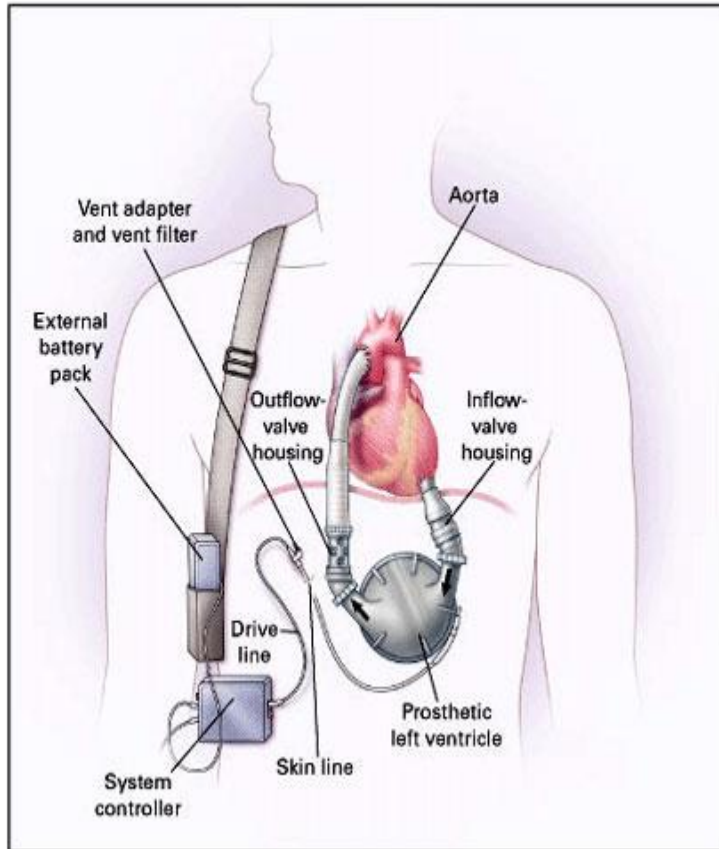
Single VAD,
(with / without Oxgenator) BiVAD



Use with
long-term VAD



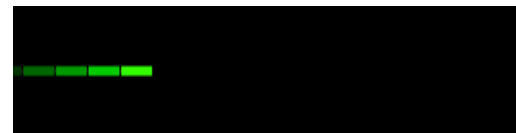
Ventricular assist device (VAD)



- Pump
(Inside or outside)
- Control system
(Outside the body)
- Energy supply
(Battery or compressed air)



Postoperative ICU care



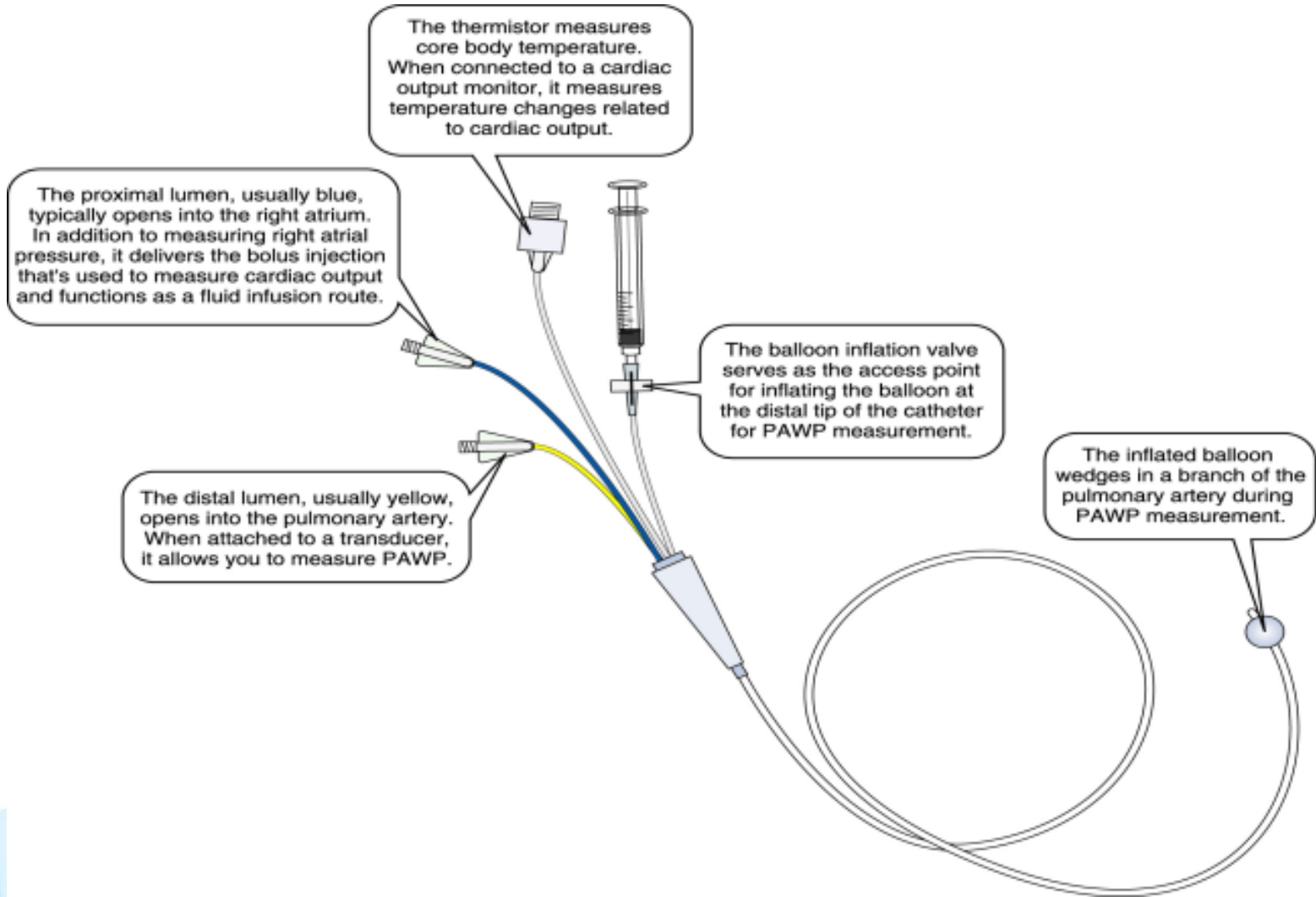


Post-operative Monitoring

- Invasive arterial pressure monitoring.
- Direct measurement of right atrial pressure(**RAP**) or central venous pressure (**CVP**).
- Measurement of left atrial or pulmonary artery wedge pressure(**PAWP**).
- Intermittent measurement of cardiac output (**CO**).
- Continuous assessment of **urinary output**.

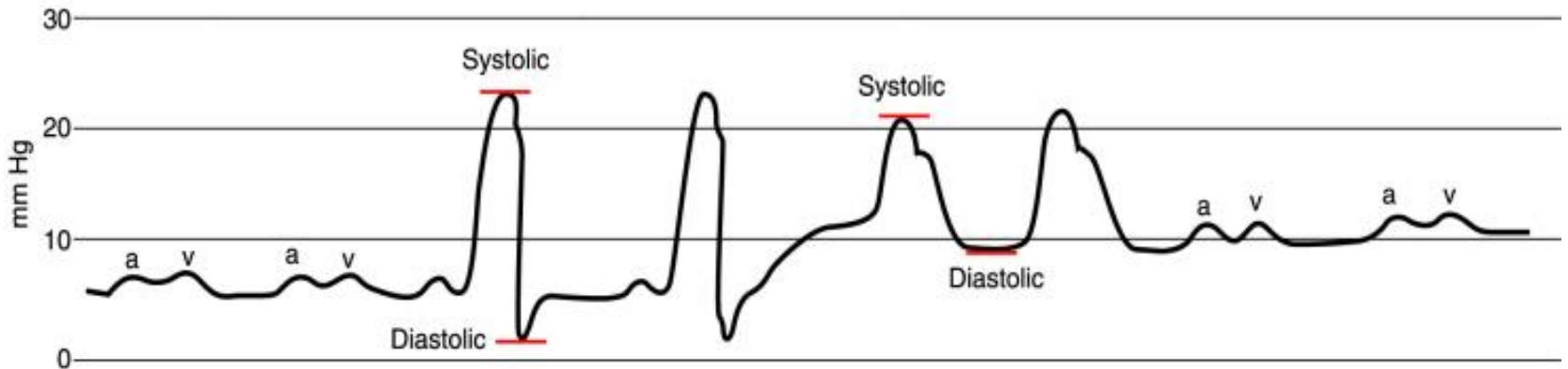
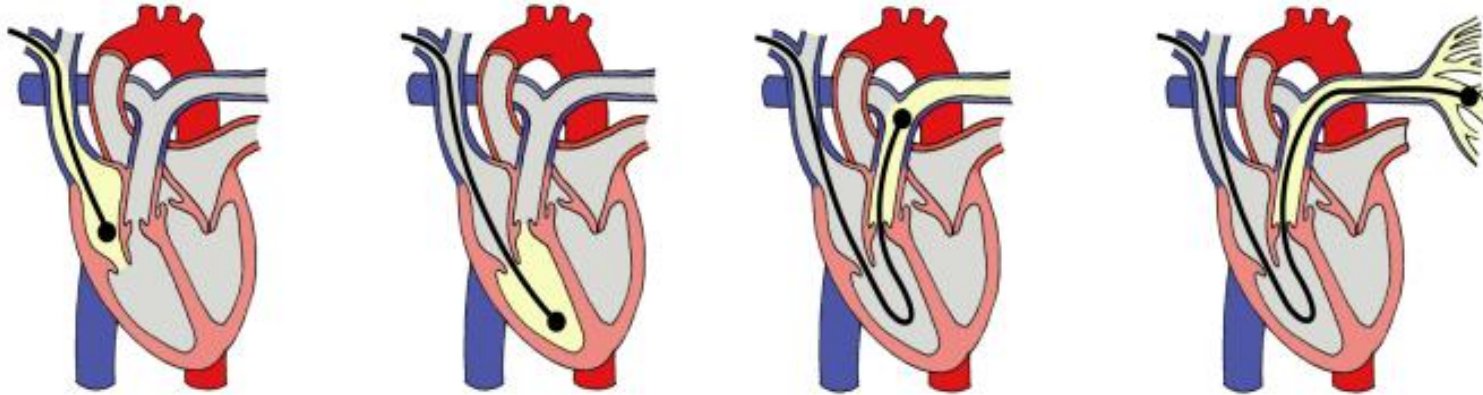


Swan-Ganz catheter





Swan-Ganz catheter- Waveform



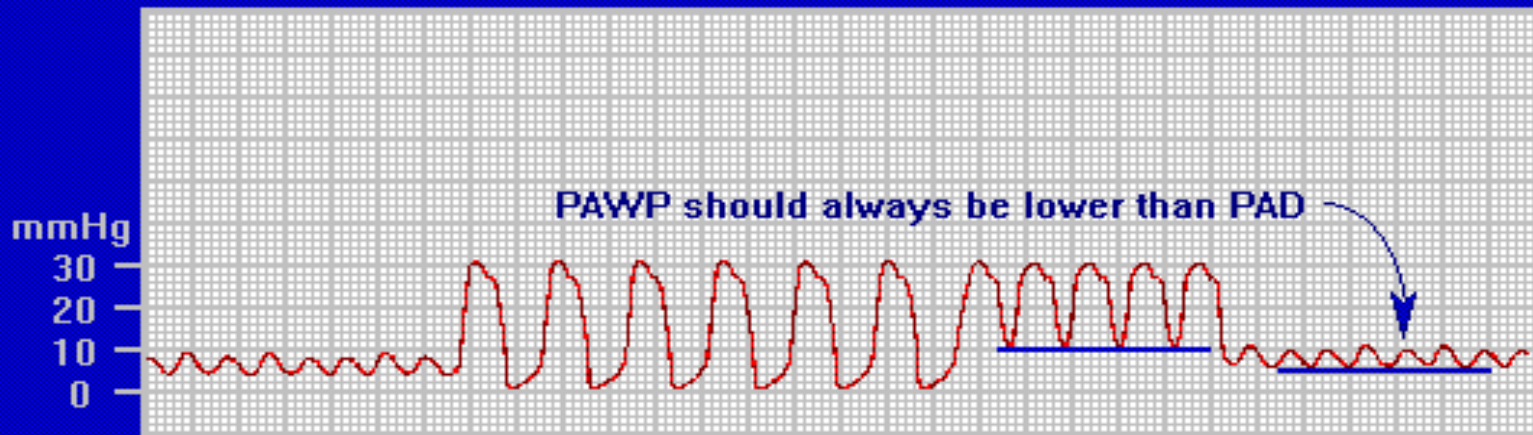
Right atrial pressure
0-8 mm Hg

Right ventricular pressure
Systolic: 20-30 mm Hg
Diastolic: 0-8 mm Hg

Pulmonary artery pressure
Systolic: 20-30 mm Hg
Diastolic: 8-15 mm Hg

Pulmonary artery
wedge pressure
8-12 mm Hg





OBTAINING PULMONARY ARTERY WEDGE VALUES

The PAWP should always be lower than the mean pulmonary artery pressure (PAP). If it appears higher than mean PAP, suspect an analytical error or that the catheter tip is not in zone III of the lung. If the catheter tip is not in zone III, the PAWP may reflect alveolar or airway pressure and would not accurately reflect left atrial pressure. In addition to the mean PAP pressure being higher than PAWP, pulmonary artery diastolic (PAD) pressure should be higher than PAWP. This is because the higher pressure in the pulmonary artery is needed to push the blood to the left atrium.

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Postoperative ICU care

- Hematologic dysfunction
- Pulmonary dysfunction
- Renal dysfunction
- Neurologic dysfunction
- Cardiac dysfunction
- Cardiac dysrhythmias

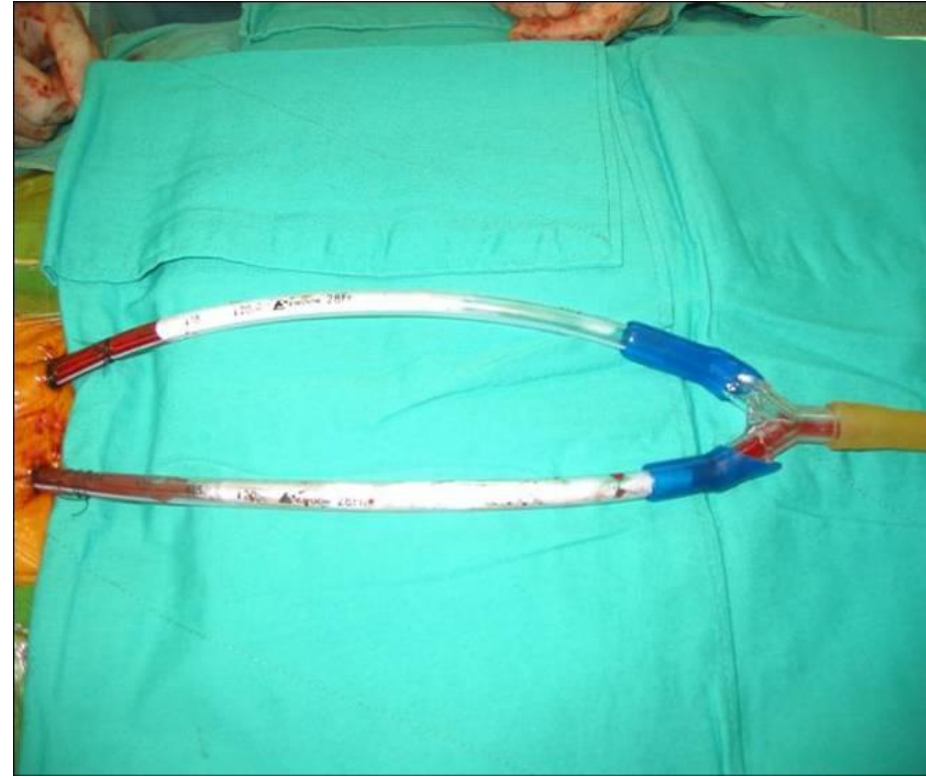
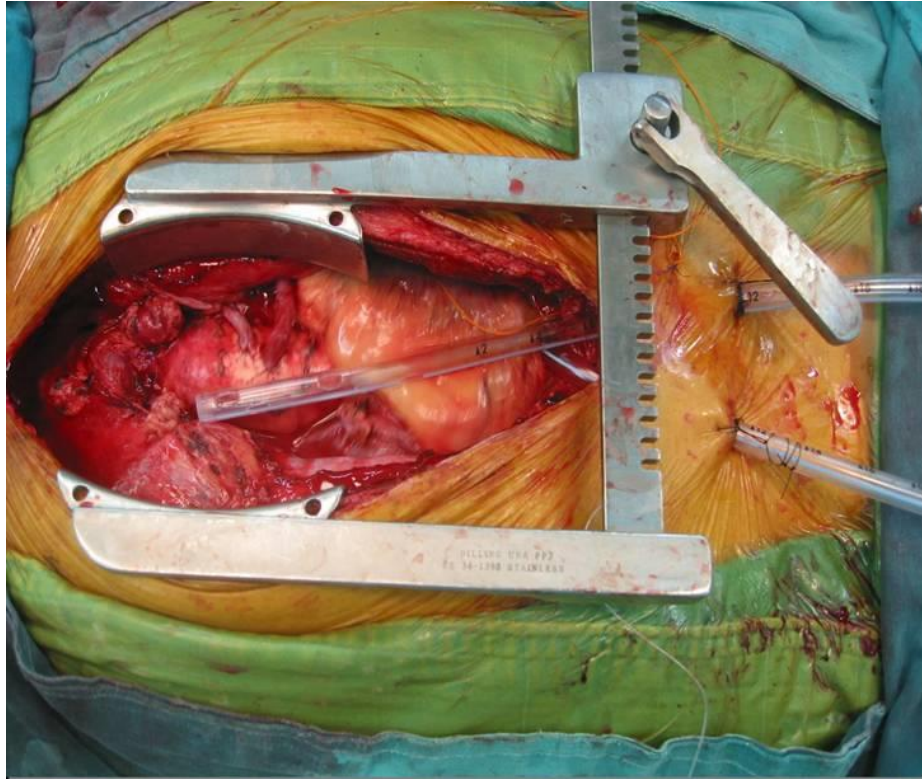


Hematologic dysfunction

- **Bleeding**
 - Incomplete surgical hemostasis
 - Residual heparin effect after CPB
 - Clotting factor depletion
 - Hypothermia
 - Postoperative hypotension
 - Hemodilution (thrombocytopenia and coagulopathy)
 - Platelet dysfunction



Mediastinal drainage tubes



P tube- **P**ericardial tube (intrapericardial drainage)

R tube- **R**etro-sternal tube (Extrapericardial drainage)



Mediastinal Reexploration

- Making a judgement: is bleeding surgical or coagulopathic ?
- Correct coagulopathy: blood products, Protamine, Tranexamic acid, DDAVP, warming the patient, controlling BP .
- Chest outputs: **greater than 400ml/h for 1 hour, greater than 300ml/h for 2 to 3 hours, and 200ml/h for 4 hours.**
- **Tamponade or hemodynamic instability.**



Pulmonary dysfunction

- **Pump lung**: secondary to the inflammatory response provoked by the bypass circuit.
- Pleural effusion
- Pneumonia
- Pulmonary embolism
- Phrenic nerve injury
- Pulmonary edema



Renal dysfunction

- **Acute renal failure**
 - 3.14% of cardiac surgery, 1.1% require dialysis.

Risk factors

- poor cardiac performance
- advanced atherosclerotic vascular disease
- impaired pre-op renal function
- long CPB time
- hemodynamic instability



Neurologic dysfunction

- **Atheroembolism** of aortic debris
- **Embolism** of left atrial or LV thrombus
- **Cerebral hypoperfusion**
- **Microembolism** of granulocyte aggregates, fibrin, and platelets
- **Air embolism**



Cardiac dysfunction

- Continuous infusion of an **inotropic** agent should be used to maintain hemodynamic stability post-operatively.
- Inotropic agents should be weaned as tolerated over the **first 3 to 5 days**.
- The **lowest effective** dose should be used.



Cardiac Arrhythmias

- Correct **electrolyte disturbances**.
- Aggressive treatment of **hypokalemia** decreases the incidence of postoperative arrhythmia. (Potassium level $> 4\text{mEq/L}$).
- **Hypomagnesemia**: an increased risks of atrial fibrillation and torsades de points.
- **Hypocalcemia** caused prolonged QT interval.



Cardiac Arrhythmias

- **Anti-arrhythmia** agents: Cordarone and Lidocaine.
- **Temporary pacing** should be initiated in the setting of relative bradycardia
- Treatment of tachyarrhythmias should be aimed at **rate control**.



敬請指教

