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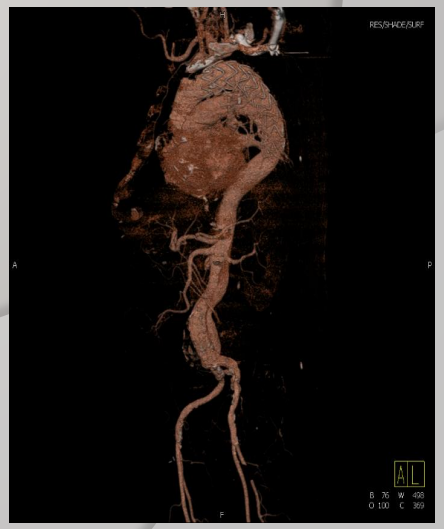
CPB AND AORTIC SURGERY

The State of the Art

From a Theoretical to a Practical Approach



M-G LAGNY, F. BLAFFART, ECCP CHU de Liège

INTRODUCTION

- Prevention

Michel JB, et al.
Novel aspects of the pathogenesis of aneurysms oh the abdominal aorta in humans. Cardiovasc Res. 2011 Aprl 1;90(1):18-27
Golledge J, Norman PE,

- Medical treatment

Current status of medical management for abdominal aortic aneurysm.Atherosclerosis, 2011. 217 (1):p.57-63.

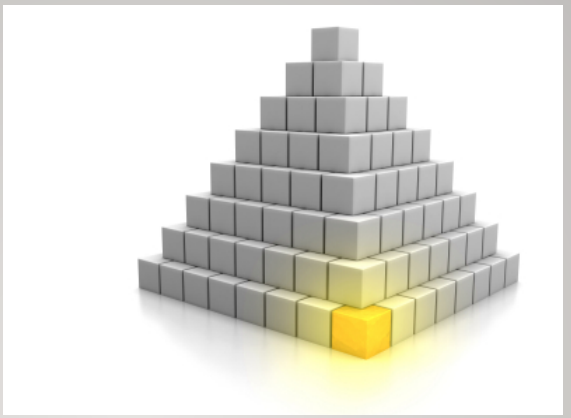
- Endovascular aortic repair

Nienaber CA, et al.
Randomized comparison of strategies for type B aortic dissection: the INvestigation of STEnt Grafts in Aortic Dissection (INSTEAD) trial. Circulation, 2009. 120(25):p.2519-28.

Hao Z, et al.
Endovascular stent-graft placement or open surgery for the treatment of acute type B aortic dissection: a meta-analysis. Ann Vasc Surg, 2012. 26(4):p.454-61.

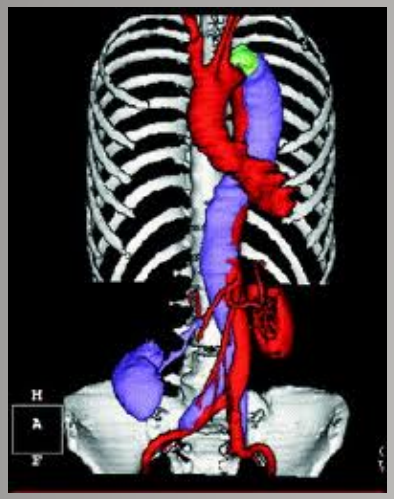
AIM OF THE TOPIC

CPB for aortic surgery: state of the art



- Knowledge
- Anatomical and pathophysiological pre-requests
- Flexibility
- Equipment

Ascending aortic surgery and arterial cannulation:



Surgical repairment

- Ascending aorta
- Left subclavian/ axillary
- Femoral
- Other

The arterial cannulation

Cannulation site	Advantages	Disadvantages
Femoral artery	Ease of access	Retrograde flow
	Size	
	Adequate flow rates	
		Proximal embolization
Axillary/subclavian artery	Reports of redu	
	mortality and st	
		Brachial plexus injury
Aortic cannulation	Speed of cannu	
Ventricular apex	Adequacy of flo	
		Ventricular injury
Direct	Antegrade flow	
	Direct cannulation of true lumen	

eTable 3: The potential advantages and disadvantages of the different cannulation sites utilized in acute type A aortic dissection

Malperfusion

Arm numbness

Embolic event

Bonser RS, et al.
Acute Aortic Dissection. JAAC Vol. 58, No. 24, 2011.

Arterial cannulation complication and perfusion: local dissection

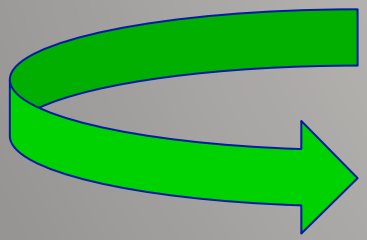
- Pressure monitoring

SWITCH TO ANOTHER CANNULATION SITE

Anticipation: Y Line

Arterial cannulation complication and perfusion: malperfusion (FLAP)

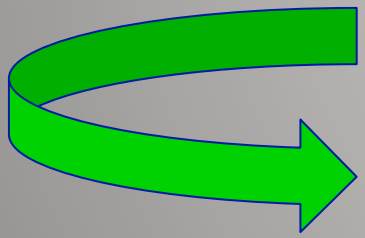
- Sudden increase of arterial line pressure
- Inequate cerebral perfusion?: NIRS, TCD
- Inadequate spinal cord perfusion (MEP)
- Late diagnostic (lactates)
- Left radial pressure



Pre and post arch arterial lines (+ left femoral)
Swich to another cannulation site
RE-INSTORE ANTEGRADE FLOW

Arterial femoral cannulation complication and perfusion: false lumen

- Pressure monitoring
- Transesophagal echocardiography(TOE)
- Arterial pressure (left radial)



CHECK THE CANNULATION
Switch to another cannulation site

Arterial cannulation complication and perfusion: embolic event

- Doppler
- Specific cannula

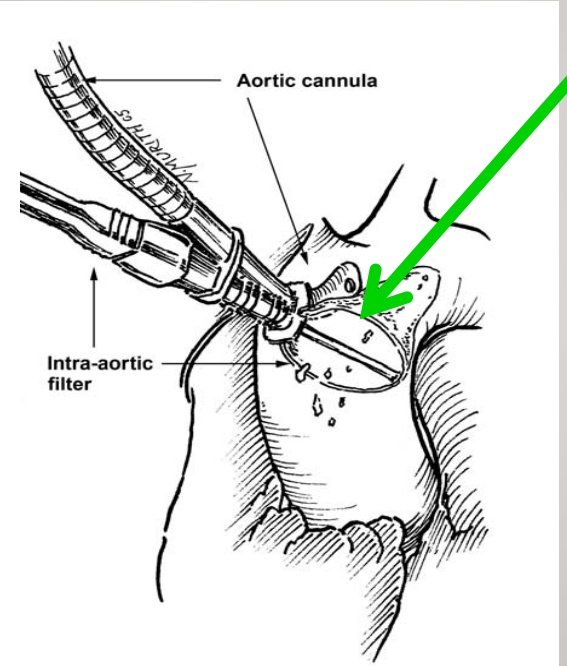


Fig. 1 *Schematic drawing shows the deployment and location of the intra-aortic filter.*

Christenson JT, et al.
Tex Heart Inst J. 2005;32(4):515-21.

Cerebral protection

Protecting the brain during aortic surgery: an enduring debate with unanswered questions.

Stein LH, Elefteriades JA,
Section of Cardiothoracic Surgery, Yale University School of Medicine, New Haven, CT 06510, USA.
Cardiothorac Vasc Anesth. 2010 Apr;24(2):316-21. Epub 2009 Jul 30.

Surgery on the ascending aorta and the arch cerebral protection

Surgery

- DHCA+SCP
- DHCA
- MHCA+SCP

Selective cerebral perfusion:

SCP

ANT

Retro

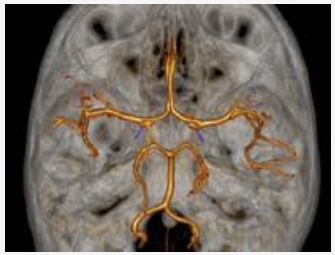
R+L carot

R axillary or SS Clav.

SVC

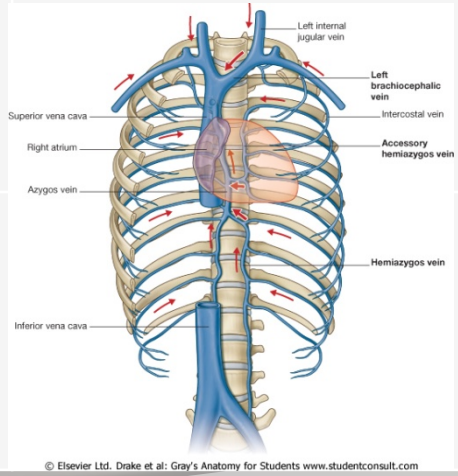
JUG

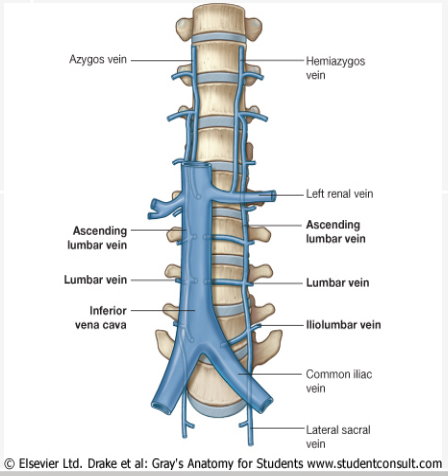
Antegrade selective cerebral perfusion: Complications and monitoring

Pro	Cons	Monitoring
Control of flow delivery	Local dissection Downstream dissection	Pression Nirs, Doppler
	Embolic load	Doppler
	Cerebral oedema in case of overflow and or over pressure	Flow and pressure control
	Integrity of the circle of Willis? in case of single carotid perfusion	NIRS, transcranial doppler, Left radial arterial pressure (60mmHg) ($JbSVO_2$) (S100 protein; NSE)

Retrograde cerebral perfusion: complications and monitoring

Pro	Cons	monitoring
Easy of access	Poor control of flow delivery, Dispertion of the flow through the Azygos vein	NIRS, transcranial doppler
Retrograde flush of the carotids	Cerebral oedema in case of overflow And or overpressure	Flow control and Venous pressure (30 mmHg)

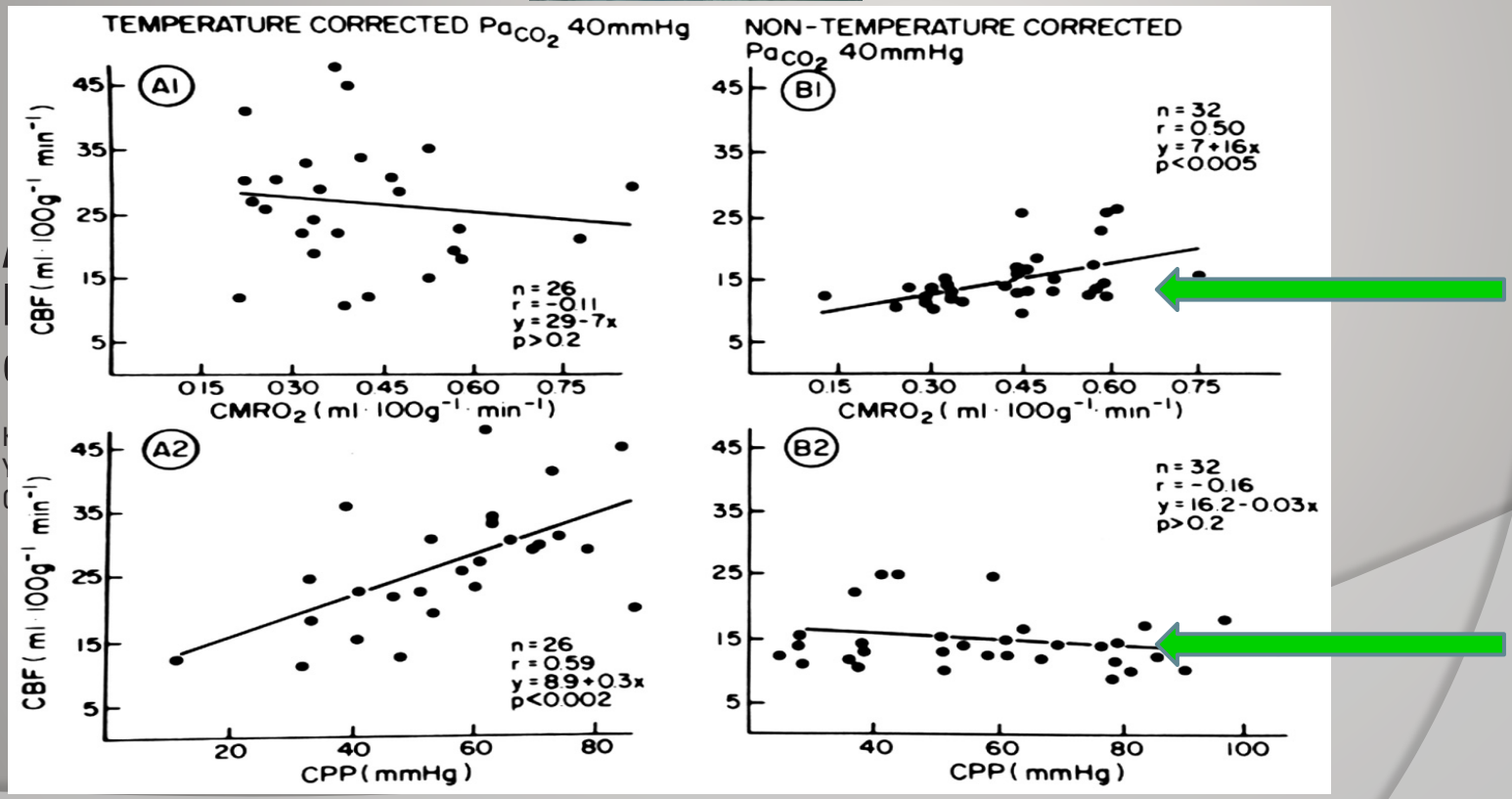




Deep hypothermia circulatory arrest: state of the art

- Respect of temperatures gradients (6-10°C max)
- Normoxia
- Hct level versus viscosity (25% Hct max)
- Homogenization of temperatures (cerebral and systemic)
- Hardware:
  - Heater cooler device
  - Efficient heat exchanger
  - Cooling helmet
  - Blanket

Deep hypothermia circulatory arrest: state of the art:blood gases management



Deep hypothermia circulatory arrest euglycemia

Avoiding Stroke During Cardiac Surgery

Seminars in Cardiothoracic and Vascular Anesthesia
14(2) 95–101

DOI: 10.1177/1089253210370902
http://scv.sagepub.com
SAGE

Kristine Kellermann, DVM[1], and Bettina Jungwirth, MD[1]

Abstract

The life saving benefits of cardiac surgery are frequently accompanied by negative side effects such as stroke, that occurs with an incidence of 2%-13% dependent to type of surgery. The etiology is most likely multifactorial with embolic events considered as main contributor. Although stroke presents a common complication, no guidelines for any routine use of pharmacological substances or non-pharmacological strategies exist to date.

Non-pharmacological strategies include monitoring of brain oxygenation and perfusion with devices such as near infrared spectroscopy and Transcranial Doppler help. Epiaortic and transesophageal echocardiography visualize aorta pathology, enabling the surgeon to sidestep atheromatous segments. Additionally can the use of specially designed aortic cannulae and filters help to reduce embolization. Brain perfusion can be improved by using antero- or retrograde cerebral perfusion during deep hypothermic circulatory arrest, by tightly monitoring mean arterial blood pressure and hemodilution. Controlling perioperative temperature and glucose levels may additionally help to ameliorate secondary damage.

Many pharmacological compounds have been shown to be neuroprotective in preclinical models, but clinical studies failed to confirm these results so far.

Remacemide, an NMDA-receptor-antagonist showed a significant drug-based neuroprotection during cardiac surgery. Other substances currently assessed in clinical trials whose results are still pending are acadesine, an adenosine-regulating substance, the free radical scavenger edaravone and the local anesthetic lidocaine.

Stroke remains as significant complication after cardiac surgery. Non-pharmacological strategies allow perioperative caregivers to detect injurious events and to ameliorate stroke and its sequelae. Considering the multi-factorial etiology though, stroke prevention will likely have to be addressed with an individualistic combination of different strategies and substances.

Deep hypothermia circulatory arrest and reperfusion injury

- Low pressure
- Normoxia
- Reperfusion solution?

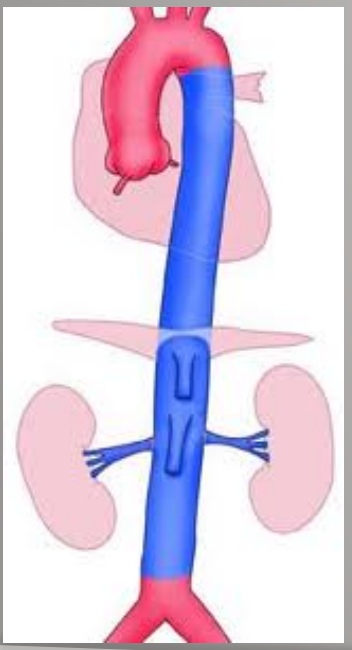
Deep hypothermic circulatory arrest and global reperfusion injury: Avoidance by making a pump prime reperfusate—A new concept

Bradley S. Allen, MD

J Thorac Cardiovasc Surg 2003; 125:625-32

- Hyperkaliemia (?) ➔ hemodiafiltration

Descending aortic surgery



Surgical repair

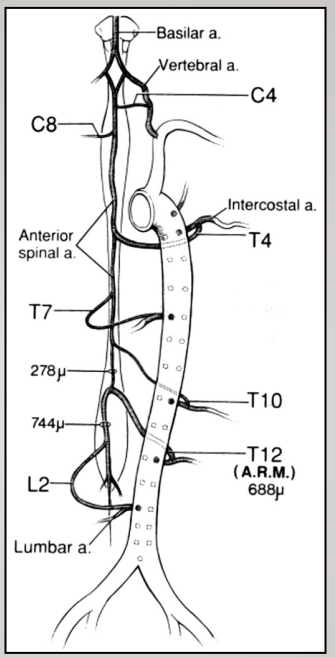
- Left-left Bypass
- Right-left Bypass
- Conventional CPB
- None

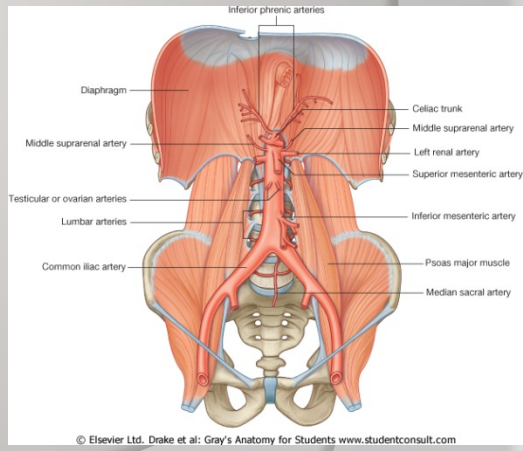
Descending aortic surgery: CPB circuit

Left-left bypass Left-right bypass	Conventional miniaturizated CPB
Left atrium – distal aorta Right atrium distal aorta	Right atrium (femoral access) – distal aorta
Centrifugal pump Autoregulation of the volemia	Centrifugal or roller pump
	Heat exchanger + oxygenator
Low heparin level	Full heparinized
	Easy shunt for selective perfusion
	Quick response to acute hemorrhagic event

Surgery on the descending aorta medullar and splanchnic selective perfusion

- Perfusion
- Local hypothermia
- Systemic mild hypothermia (32°C)





Medullar and splanchnic perfusion: complications and monitoring

Complications	monitoring
Local dissection	Q-Pressure
oedema in case of overflow and or over pressure or brain herniation	CSF drainage (10mmHg)
Malperfusion Upstream embolism	Flow, regional pressure (60mmHg), Doppler flowmetry MEP (motor evoquated potential). Mucosal pH tonometry NIRS ?

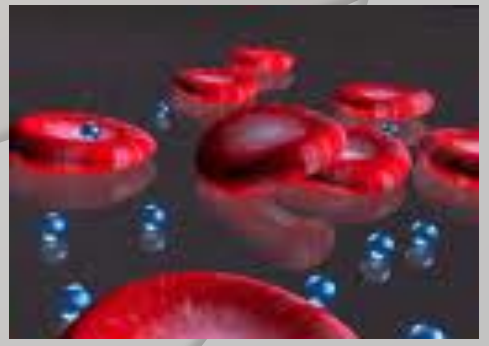
Coagulation management

Thromboelastometry-guided administration of fibrinogen concentrate for the treatment of excessive intraoperative bleeding in thoracoabdominal aortic aneurysm surgery

Niels Rahe-Meyer, MD, MSc, PhD,[a] Cristina Solomon, MD,[a] Michael Winterhalter, MD,[a] Siegfried Piepenbrock, MD,[a] Kenichi Tanaka, MD, MSc, PhD,[b] Axel Haverich, MD,[c] and Maximilian Pichlmaier, MD[c]

Blood management

- Selective suction blood management
- Specific filtration
- Cell saving process
- Selective allogenic blood component transfusion



Conclusions

- Aorta surgery is a team work
- Multiple modal approaches
- Engering developments
- EBM and EBP

Thank you for your attention