Marc-Gilbert Lagny
Francine Blaffart
ECCP
Department of Nursing and
Department of Cardiovascular and Thoracic Surgery
Prof. JO Defraigne
University Hospital of Liège, Belgium.
CPB AND AORTIC SURGERY

The State of the Art

From a Theoretical to a Practical Approach
INTRODUCTION

- Prevention

Michel JB, et al.  

Golledge J, Norman PE,

- Medical treatment


- Endovascular aortic repair

Nienaber CA, et al.  

Hao Z, et al.  
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

<table>
<thead>
<tr>
<th>Cannulation site</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femoral artery</td>
<td>Ease of access</td>
<td>Retrograde flow</td>
</tr>
<tr>
<td></td>
<td>Size</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adequate flow rates</td>
<td></td>
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<tr>
<td></td>
<td>Proximal embolization</td>
<td></td>
</tr>
<tr>
<td>Axillary/subclavian artery</td>
<td>Reports of reduced mortality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and sternal pain</td>
<td>Dural or pericardial injury</td>
</tr>
<tr>
<td>Aortic cannulation</td>
<td>Speed of cannulation</td>
<td></td>
</tr>
<tr>
<td>Ventricular apex</td>
<td>Adequacy of flow</td>
<td></td>
</tr>
<tr>
<td>Direct</td>
<td>Antegrade flow</td>
<td>Ventricular injury</td>
</tr>
<tr>
<td></td>
<td>Direct cannulation of true lumen</td>
<td></td>
</tr>
</tbody>
</table>

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

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**Bonser RS, et al.**

*Acute Aortic Dissection. JAAC Vol. 58, No. 24, 2011.*

M-G LAGNY, F. BLAFFART, ECCP CHU de Liège
Arterial cannulation complication and perfusion: local dissection

- Pressure monitoring

SWITCH TO ANOTHER CANNULATION SITE

Anticipation: Y Line

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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)
Switch to another cannulation site
RE-INSTORE ANTEGRADE FLOW
Arterial femoral cannulation complication and perfusion: false lumen

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

CHECK THE CANNULATION
Switch to another cannulation site
Arterial cannulation complication and perfusion: embolic event

- Doppler
- Specific cannula

Christenson JT, et al.  
Cerebral protection

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

Surgery on the ascending aorta and the arch cerebral protection
Selective cerebral perfusion:

- SCP
- ANT
- Retro
- R+L carot
- R axillary or SS Clav.
- SVC
- JUG
# Antegrade selective cerebral perfusion: Complications and monitoring

<table>
<thead>
<tr>
<th>Pro</th>
<th>Cons</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control of flow delivery</td>
<td>Local dissection</td>
<td>Pression</td>
</tr>
<tr>
<td></td>
<td>Downstream dissection</td>
<td>Nirs, Doppler</td>
</tr>
<tr>
<td></td>
<td>Embolic load</td>
<td>Doppler</td>
</tr>
<tr>
<td></td>
<td>Cerebral oedema in case of overflow and or over pressure</td>
<td>Flow and pressure control</td>
</tr>
<tr>
<td><img src="image1.png" alt="Image of cerebral arteries" /></td>
<td>Integrity of the circle of Willis in case of single carotid perfusion</td>
<td>NIRS, transcranial doppler, Left radial arterial pressure (60mmHg) (JbSVO₂) (S100 protein; NSE)</td>
</tr>
</tbody>
</table>
Retrograde cerebral perfusion: complications and monitoring

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

M-G LAGNY, F. BLAFFART, ECCP CHU de Liège
Avoiding Stroke During Cardiac Surgery

Kristine Kellermann, DVM¹, and Bettina Jungwirth, MD¹

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

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

<table>
<thead>
<tr>
<th>Complications</th>
<th>monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local dissection</td>
<td>Q-Pressure</td>
</tr>
<tr>
<td>oedema in case of overflow and or over pressure or brain herniation</td>
<td>CSF drainage (10mmHg)</td>
</tr>
<tr>
<td>Malperfusion Upstream embolism</td>
<td>Flow, regional pressure (60mmHg), Doppler flowmetry MEP (motor evoquated potential). Mucosal pH tonometry NIRS ?</td>
</tr>
</tbody>
</table>
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
- Engineering developments
- EBM and EBP
Thank you for your attention