Less invasive cooling strategies for aortic aneurysm surgeries

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June, 2012
History

Dr. C. Walton Lillehei

- 1918-1999
- Bubble oxygenator
- Improvements of the Heart Lung Machine

1953: First Heart Lung Machine
John Gibbon, Philadelphia

- Greater infrastructure
Hypothermia in cardiovascular surgery

Hypothermia

- Definition: a condition in which an organism's temperature drops below the required level for normal metabolism and body functions.
- Subdivided into four different degrees:
  - Mild (32 - 35°C )
  - Moderate (28 - 32°C )
  - Severe (20 - 28°C )
  - Profound ( < 20ºC)

Hypothermia preserves organ functions during cardiac surgery
## Protective effects of hypothermia

<table>
<thead>
<tr>
<th>System</th>
<th>Effects</th>
</tr>
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<tbody>
<tr>
<td><strong>CNS</strong></td>
<td>Depression of cerebral metabolism; EEG abnormality; decline in cerebral</td>
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<tr>
<td></td>
<td>blood flow and cerebral function</td>
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<tr>
<td><strong>Cardiovascular</strong></td>
<td>Tachy/bradycardia, vasoconstriction, ↑CO, HTA, prolonged systole,</td>
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<tr>
<td></td>
<td>decreased ventricular arrhythmia threshold</td>
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<tr>
<td><strong>Respiratory</strong></td>
<td>tachypnea., decrease in oxygen consumption; 50% ↓ in carbon dioxide</td>
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<td></td>
<td>production per 8°C drop in temperature</td>
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<tr>
<td><strong>Renal and endocrine</strong></td>
<td>↑ in renal flow, intact renal autoregulation, decrease in basal</td>
</tr>
<tr>
<td></td>
<td>metabolism</td>
</tr>
<tr>
<td><strong>Neuromuscular</strong></td>
<td>shivering</td>
</tr>
<tr>
<td><strong>Metabolism</strong></td>
<td>Decreased metabolism, acidosis, ↑lactates</td>
</tr>
</tbody>
</table>
# Adverse consequences of hypothermia

<table>
<thead>
<tr>
<th>Category</th>
<th>Effect</th>
</tr>
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<tbody>
<tr>
<td>Cardiovascular</td>
<td>Arrhythmias secondary to potassium loss</td>
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<tr>
<td></td>
<td>Increased plasma viscosity</td>
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<tr>
<td></td>
<td>Vasoconstriction impairing microcirculation</td>
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<tr>
<td>Coagulation</td>
<td>Impaired coagulation</td>
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<td></td>
<td>Reduced platelet count</td>
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<tr>
<td>Renal and metabolic</td>
<td>Reduced glomerular filtration rate</td>
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<td></td>
<td>Metabolic acidosis</td>
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<td></td>
<td>Hyperglycaemia secondary to impaired glucose metabolism</td>
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<td></td>
<td>Effects on pharmacodynamics and pharmacokinetics</td>
</tr>
<tr>
<td>Cerebral</td>
<td>Vasoconstriction during cooling</td>
</tr>
<tr>
<td></td>
<td>Brain injury from hyperthermia during rewarming</td>
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</tbody>
</table>
Perfusion techniques during surgery of thoracic and thoraco-abdominal aorta

Standard rules

- Surface induced hypothermia
- Full cardiopulmonary bypass
- Deep hypothermia with circulatory arrest
- Apico-aortic shunting with heparin coated tubing (Gott shunt)
- Left heart bypass with heparin coated centrifugal pump and tubing
- Partial cardiopulmonary bypass with heparin coated perfusion equipment

Ludwig K von Segesser

Perfusion techniques during surgery of thoracic and thoraco-abdominal aorta our strategies

N=405 pts.

- Moderate - mild hypothermia (28-32°C)
- Organ perfusion during whole surgery
- Femoral artery and right atrium cannulation
- Off pump thoracoabdominal surgery-no circulatory support

• Follow-up 1-144 months
Surgery in aortic dissection n = 301 pts.

88pts in cardiogenic shock
80 pts tamponada and severe metabolic acidosis

CBP time(min)  98 ±23.5
Xclamp time (min) 56.5 ±6.2
Antegrade perfusion (min) 23 ±9
Deepest rectal temperature 30.9 ±2.4

Mortality rate - 4.3 % (17 pts)
Surgery in aortic dissection n = 301 pts.

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Surgery of aortic aneurysm $n = 104$ pts

25 thoracoabdominal aneurysms
79 thoracic aneurysms

CBP time (min) $122 \pm 23.5$
Xclamp time (min) $67.5 \pm 6.2$
Antegrad perfusion (min) $23 \pm 9$
Deepest rectal temperature $29.9 \pm 2.4$

Mortality rate - 6 (5.76%)
Surgery of aortic aneurysm and aortic arch n = 14 pts

K.B. 25 y. old
02/2010 - arch mycotic aneurysm
Op. arch replacement with left a.subclavia re-implantation

09/2011 – reoperation, rupture on the new created aneurysm and broncho-aortal fistula

9 months surviving period after second operation
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M.R. 65yold

1st op. (2001) Sy Leriche - aorto-bilijacal bypass

2nd op. (2004) re-op. extranatomical by-pass right subclavian arterio femoro-femoral (due to oclusion of the abdominal aorta – proximal of the previous implanted graft

3rd (2011) op. re-operation – graft right subclavia-femoro-fem.

4th (02/2012) op. aortic arch-descending aneurysm -

Follow up 7 months
Surgery of descending aorta n = 74 pts

A 66-year-old man, dysphagia, breathless period, chest pain, fatigue.

Ultrasound - massive aortic thoracic aneurysm

Medical History – positive for HTA

(2010) Thoracoabdominal aneurysm-surgical technique through median sternotomy partial CBP – T-27,6oC, Ao clamp-45min,CBP 180min

18days respiratory machine percutaneous tracheotomy
29th day decannulation
38th day discharged
Complication - amputation of the distal phalanga of the left II finger
Off-pump surgery of thoracoabdominal aneurysm-
urgent case

60 old man-
Severe abdominal pain, vomiting, pulsatio in the abdominal region

13 h. respiratory machine
2nd day mobilization
3rd day chest tube out
9th day discharged
No - complications

(2008) Replacement of distal thoracal and abdominal aorta Y graft with both iliacal arteries); reimplantation of truncus coeliacus and art.mesenterica

Pre-op 64 MSCT scan

Post-op 64 MSCT scan
Off-pump surgery of thoracoabdominal aneurysm - urgent case

M.Z. 47y, 2006 – I st op. replacement of acsend ing aorta (dissection)

2009- Dg - aneurysm of thoraco-abdominal part of the aorta

Postoperatively-
Hemodinamicaly stable
Late paraplegia
Deep depressive syndrome
Exitus lethalis after 6,5 months
Thoracoabdominal aneurysm - urgent case

(03/2012) A.I. 70y old
Urgency - blood vomiting
CT scan - thoracoabdominal aneurysm with an aorto-esophageal fistula
Surgery
Thoracoabdominal aorta replacement with reimplantation of trunc.coeliacus, a.mes.sup left, a.renalis and distal intercostal arteries
T-33,60C
Ao.clamp - 105 min
EKC – 160 min

Pre op.

Post op.

Stenting of the aorto-esophageal fistula
Thoracoabdominal aneurysm - urgent case

Surgery
1. CABGx2 OPCAB
2. Thoracoabdominal aorta replacement with replacement of truncus coeliacus, a.mes.sup, both renal arteries

Pre op.
S.O.65y old
Retaint rupture of the thoracoabdominal aneurysm on the suprarenal level
Coronary artery disease

T=34oC hypothermia
Ao clamp 166min
EKC – 300 min

Postop.
## Results N=405pts

<table>
<thead>
<tr>
<th>Complications</th>
<th>Dissections (301pts)</th>
<th>Aneurysm (104pts)</th>
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<tbody>
<tr>
<td>Multiple organ failure</td>
<td>10 (3.3%)</td>
<td>11 (10.5%)</td>
</tr>
<tr>
<td>Cardiac complications</td>
<td>4 (1.3%)</td>
<td>6 (5.7%)</td>
</tr>
<tr>
<td>Pulmonary complications</td>
<td>13 (4.3%)</td>
<td>6 (5.7%)</td>
</tr>
<tr>
<td>Stroke</td>
<td>12 (3.9%)</td>
<td>5 (4.8%)</td>
</tr>
<tr>
<td>Hemorrhage</td>
<td>15 (4.9%)</td>
<td>10 (9.6%)</td>
</tr>
<tr>
<td>Acute renal insuff. with CVVHD treatment</td>
<td>15 (4.9%)</td>
<td>&amp; (6.7%)</td>
</tr>
<tr>
<td>Mortality</td>
<td>17 (4.3%)</td>
<td>8 (7.6%)</td>
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Conclusion:

- Mild-moderate hypothermia is appropriate technique in most of complex surgical aortic procedures.
- Techniques avoiding EKC and hypothermia ensures better clinical outcome in patient with less metabolic disorders.
- Aortic dissections can be operated on mild hypothermia (32 C) with preserved cerebral and systemic organ perfusion.
- Thoracic and thoraco-abdominal aneurysms might be operated in mild hypothermia (30 C) on extracorporeal circulation (cannulating places: femoral vein and right atrium in a condition with or without cardioplegia.
Kao i uvjek - na kraju

I POREĐ OPERACIJE

PACIJENTU JE IPAČ DOBRO

Prof dr.sc. Ino Husedžinović, dr.med.