SURGICAL APPROACH OF VISCERAL, SPINAL CORD AND CEREBRAL PROTECTION

DR. MARC SCHEPENS
AZ ST. JAN BRUGGE
BELGIUM
ISCHEMIA OF END-ORGANS

PROTECTION OF END-ORGANS

HOW TO DO IT?
ARTERIAL INFLOW  FUNCTIONAL INTEGRITY
# Tolerable Ischemic Times

<table>
<thead>
<tr>
<th>Tissue Type</th>
<th>Tolerable Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kidneys</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Guts</td>
<td>&gt; 120 minutes</td>
</tr>
<tr>
<td>Lower Legs</td>
<td>&gt; 200 minutes</td>
</tr>
<tr>
<td>Spinal Cord</td>
<td>?? Collateral Circulation 30 minutes</td>
</tr>
<tr>
<td>Brain</td>
<td>3 minutes</td>
</tr>
<tr>
<td>Heart</td>
<td>?? Collateral Circulation Max 4 hours</td>
</tr>
</tbody>
</table>
SPINAL CORD PROTECTION
HYPOPHERFUSION
HYPOTENSION
SPASM
STEAL
EDEMA
THROMBOSIS
REPERFUSION
INJURY

MONRO-KELLY PRINCIPLE !!!!
INCIDENCE OF PARAPLEGIA/PARAPARESIS

IN THORACOABDOMINAL AORTIC SURGERY

- SUBSTANTIAL REDUCTION OVER LAST 10 YEARS
  - 3 % TO 5 %

IN AORTIC ARCH SURGERY

- LESS THAN 1 %
- NOT A PROBLEM
ADAMKIEWICZ A. DIE BLUTGEFÄSSE DES MENSCHLICHEN RÜCKENMARKEOBERFLÄCHE.
AKAD WISS 1881:84 und 1882:85
CROSS-CLAMP TIME
30 MINUTES
SPINAL CORD FUNCTIONAL INTEGRITY

LEFT HEART BYPASS

CEREBROSPINAL FLUID DRAINAGE

(PERMISSIVE) HYPOTHERMIA

EVOKEE POTENTIAL MONITORING

REIMPLANTATION OF CRITICAL INTERCOSTAL/LUMBAR ARTERIES
LEFT HEART BYPASS
REDUCTION OF NEUROLOGIC DEFICITS FROM 21% TO 3% DUE TO THE INTRODUCTION OF LEFT HEART BYPASS

LEFT HEART BYPASS

- NO HEPARINE
- OPTIMAL CONTROL OF HEMODYNAMICS
- REWARMING
- SPINAL MONITORING
- VISCERAL PERFUSION
- REDUCTION OF ISCHEMIA VIA STAGED CLAMPING

BASIC SET-UP

VISCERAL PERFUSION
LEFT ATRIUM

1. FRAGILE
2. RYTHM DISTURBANCES
3. AIR EMBOLISM
LEFT ATRIUM
LEFT PULM. VEIN
PROX. AORTA

LEFT FEM. ART.
LEFT COMM. I LIAC ART.
ABDOMINAL AORTA
ANEURYSM ITSELF

3 LITER
+ 5000 u HEPARINE

PHYS. SALT
+ PLASMA
EXPANDER

VENOUS BUBBLE TRAP

HEAT EXCHANGER
PERMISSIVE HYPOTHERMIA
EVOKED POTENTIAL MONITORING
SEP

brain

via posterior horn

d peripheral nerve

MEP

brain

via anterior horn

peripheral nerve
EP’S ALLOW FOR
ADJUSTMENT OF OPERATIVE STRATEGY

INCREASE OF PROXIMAL BLOOD PRESSURE
INCREASE OF DISTAL PERFUSION PRESSURE
DRAIN CSF-FLUID
NORMAL SEP AND MEP HAVE A STRONG NEGATIVE PREDICTIVE VALUE

NO LOSS OF SIGNALS = NORMAL FUNCTIONING
REQUIRES SPECIAL TRAINED PERSONNEL

FALSE NEGATIVES AND FALSE POSITIVES
ALMOST ALL INHALED OR INTRAVENOUS ANESTHETICS MAY RESULT IN EP-CHANGES THAT ARE INDISTINGUISHABLE FROM REAL NEURAL ISCHEMIA
REIMPLANTATION OF CRITICAL ARTERIES
DIRECT REIMPLANTATION INTO THE VASCULAR PROSTHESIS
AORTIC DISSECTION IS A PROTECTIVE FACTOR FOR SPINAL CORD DAMAGE

COSELLI ET AL. ANN THORAC SURG 1997;63:28-36

PRESENCE OF AORTIC DISSECTION 0.40 ODDS RATIO
CEREBROSPINAL FLUID DRAINAGE
WHY?

AORTIC CROSS-CLAMPING

SPINAL CORD PERFUSION PRESSURE = MEAN ARTERIAL PRESSURE – CSF-PRESSURE

CSF PRESSURE

DISTAL AORTIC PRESSURE

CSF DRAINAGE

DISTAL AORTIC PERFUSION

CSF DRAINAGE

DISTAL AORTIC PERFUSION

SPINAL CORD PROTECTION

SPINAL CORD PROTECTION
HOW ?
THE COMBINATION OF LEFT HEART BYPASS AND CSF-DRAINAGE IS PARTICULAR PROTECTIVE


CSF X MEP 0.28 ODDS RATIO
RISKS ?
# RISKS OF SPINAL FLUID DRAINAGE

<table>
<thead>
<tr>
<th>Complication</th>
<th>n</th>
<th>% (n/1107)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSF leak</td>
<td>7</td>
<td>0.64</td>
</tr>
<tr>
<td>Intracranial hemorrhage</td>
<td>5</td>
<td>0.45</td>
</tr>
<tr>
<td>Meningitis</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Headache</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Fractured catheter</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17</strong></td>
<td><strong>1.5</strong></td>
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</table>

HOW LONG?

3 consecutive days

< 10 mm Hg

Drainage – measurement – drainage - measurement
DELAYED SPINAL CORD DAMAGE
Delayed Spinal Cord Deficits After Thoracoabdominal Aortic Aneurysm Repair

Daniel R. Wong, MD, MPH, Joseph S. Coselli, MD, Karen Amerman, MS, CRNA, John Bozinovski, MD, Stacey A. Carter, BA, William K. Vaughn, PhD, and Scott A. LeMaire, MD

Background. Limited information is available about the treatment and outcomes of delayed paraplegia after thoracoabdominal aortic aneurysm (TAAA) repair. The objective of this study was to assess factors that precipitate and favorably affect delayed-onset neurologic deficits.

Methods. Over a 19-year period, 2,368 TAAA repairs were performed. Of the 93 patients (3.9%) who had postoperative paraplegia or paraparesis, 34 (37%) initially had intact neurologic function, but a delayed spinal cord deficit developed. We retrospectively examined clinical factors and events associated with development of the deficits, treatments used, and outcomes. Factors related to functional status were evaluated by comparing survivors who were ambulatory at discharge or transfer with those who were not.

Results. The delayed deficits occurred between 13 hours and 91 days postoperatively and were associated with a period of hypotension in 9 patients (26%). Two patients (6%) died in hospital. Of the 32 patients discharged or transferred, 13 (41%) were ambulatory. Poor functional outcomes were associated with female sex, intraoperative cerebrospinal fluid drainage, fewer intercostal arteries reattached, and administration of corticosteroids or osmotic diuretics. The actuarial survival rate at 2 years was 80%, 13% for the ambulatory patients and 32% 12% for the nonambulatory patients (p = 0.002).

Conclusions. Although precipitating episodes of hypoperfusion were common, most cases of delayed paraplegia occurred without such events, suggesting that other factors may play an important role in the development of this complication. Ambulatory status at discharge significantly predicts midterm survival.

DELAYED DEFICITS

13 HOURS – 91 DAYS

ARTERIAL HYPOTENSION

HYPOXEMIA

RYTHM DISTURBANCES (AF)

LOW HEMOGLOBINE
THERAPEUTIC MANEUVERS USED TO TREAT DELAYED-ONSET PARAPLEGIA

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vasopressor agents</td>
<td>21%</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>82%</td>
</tr>
<tr>
<td>PRBC transfusion</td>
<td>6%</td>
</tr>
<tr>
<td>Osmotic diuresis</td>
<td>76%</td>
</tr>
<tr>
<td>Intravenous naloxone</td>
<td>6%</td>
</tr>
<tr>
<td>CSF drainage</td>
<td></td>
</tr>
<tr>
<td>- Continuation with existing drain</td>
<td>9%</td>
</tr>
<tr>
<td>- Reinsertion of drain</td>
<td>29%</td>
</tr>
<tr>
<td>- Insertion of new drain</td>
<td>29%</td>
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THE COLLATERAL NETWORK CONCEPT
Eva Griepp, Randall Griepp

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Eva Griepp, Randall Griepp

Etz et al. Direct spinal cord perfusion pressure monitoring in extensive distal aortic aneurysm repair
CEREBRAL PROTECTION
**DHCA:** deep hypothermic circulatory arrest

**ASCP:** antegrade selective cerebral perfusion

**RCP:** retrograde cerebral perfusion
NEUROMONITORING

1. BILATERAL RADIAL ARTERY PRESSURE

2. ELECTRO-ENCEPHALOGRAPHY

3. BILATERAL TCD

4. NEAR INFRARED SPECTROSCOPY
<table>
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<tr>
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<th>DHCA</th>
</tr>
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<tbody>
<tr>
<td>No time limits</td>
<td>&lt; 30 – 40 min.</td>
</tr>
<tr>
<td>Cannulae</td>
<td>Empty field</td>
</tr>
<tr>
<td>No blood</td>
<td>No blood</td>
</tr>
<tr>
<td>Glue: partial</td>
<td>Glue : circumferential</td>
</tr>
<tr>
<td>Risks of encircling</td>
<td>Cooling and rewarming</td>
</tr>
<tr>
<td>vessels</td>
<td></td>
</tr>
<tr>
<td>Risk of dislodging</td>
<td>Optimal protection of other organs</td>
</tr>
<tr>
<td>atherosclerotic debris</td>
<td></td>
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Antegrade Selective Cerebral Perfusion (ASCP)
Medtronic DLP

- 15 Fr.
- retrograde cardioplegia cannula
- balloon inflatable
- pressure line
- silicone
- armed
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BILATERAL TRANSCRANIAL DOPPLER MONITORING
1. Kinking
2. Malpositioning
3. Emboli
NEAR INFRARED SPECTROSCOPY
Cerebral Oximetry during Type A dissection (ASCP) repair

- Start CPB
- Start ASCP
- Stop ASCP
- Haemodynamic instability
- EEG
- Asymmetry

Time

Sat\%
BILATERAL RADIAL ARTERY PRESSURE MONITORING
VISCERAL PROTECTION

GUTS, LIVER, SPLEEN, STOMACH, ...
RINGER’S ACETATE
MANNITOL
4°C
TEAM WORK
SURGEON

ASSISTANT 1

ASSISTANT 2

ANESTHESIOLOGIST

PERFUSIONIST

SCRUB NURSE
THANK YOU FOR YOUR ATTENTION