SPINAL CORD PROTECTION STRATEGIES WORKSHOP

Dr Brigitta Brandner
UCLH
Spinal Cord Blood Supply
Incidence

- 2.5% paraplegia/paraparesis (EUROSTAR)
- Some studies up to 8%

- Immediate, recurrent and delayed
  37% deficits are delayed: present 13 hours – 91 days post op
  >50% will resolve with treatment

- Associated morbidity and mortality.
  2 year Survival 32% vs 80% with non ambulatory deficit
SCI Risk factors

- Previous AAA
- L subclavian occlusion
- Emergency procedure
- >205mm or >3 stent grafts
- Hypotension (MAP <70, or systolic<80mmHg)
- Renal impairment
- Involvement AKA/Hypogastric
CT or MR angiography : AKA identification
Internal iliac blood flow
Distal aortic perfusion
X clamp time
Reimplantation intercostals
Revascularisation L subclavian, hypogastric arteries
Staged procedures
Paraplegia prevention endografts
Thromboembolism
Anaesthetic Factors

- Maintenance Spinal Cord Perfusion Pressure (SCPP)
- CSF Drainage
- CSF targets
- Intra operative Monitoring
- Hypothermia
- Pharmacological strategies
- Preconditioning
Spinal Cord Perfusion Pressure

- SCPP = MAP – (CSF Pressure + CVP)
  - Lost autoregulation, pressure dependent
  - MAP >80mmHg, SCPP >60mmHg
  - Continuous vs Intermittent monitoring

- Oxygen delivery
  - DO2 = CO ((Hb x SpO2 x 1.34) + PaO2 x 0.003)
Overall evidence for beneficial effect
Risk reduction in the order of 80%
50% post op deficits can be reversed with spinal drain insertion

Hnath et al 2008, n=121, TEVAR, reduction PNID 8% to 0%

Complications significant
Standardized management
Recent best practice published
Lumbar drain complications

- **Insertion**
  Failure, Spinal cord & Nerve root injuries, Bloody tap (5%) Neuraxial haematoma, PDPH (0.5%)  

- **Catheter**
  Fracture (1.8%), Infection (1.2%), local irritation (15%)  

- **Drainage**
  Intracranial hypotension, headache, VI n palsy, Intracranial haemorrhage (3%), death (0.6%), Chronic CSF leak.
<table>
<thead>
<tr>
<th>Issue</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coagulation</td>
<td>No LMWH for 24 h (high dose); 12 h (low dose) No clopidogrel -7d, No ticlopidine 10 14 d, No abciximab -24-48h, Noeptifibatide or tirofiban -4-8h, platelets&gt;100-103, INR&lt;1.3, normal aPTT</td>
</tr>
<tr>
<td>Localized infection</td>
<td>Avoid placement of drain in an area of localized infection</td>
</tr>
<tr>
<td>Intracranial pressure</td>
<td>Avoid placement of drain if patient has evidence of increased intracranial pressure</td>
</tr>
<tr>
<td>Insertion</td>
<td></td>
</tr>
<tr>
<td>Asepsis</td>
<td>Alcohol-based chlorhexidine solutions, sterile draping, thorough handwashing with removal of jewelry, sterile surgical gloves, masks, sterile gown</td>
</tr>
<tr>
<td>Awake vs asleep</td>
<td>Suggest awake to allow for patient feedback (i.e., pain/paraesthesia)</td>
</tr>
<tr>
<td>Timing of insertion</td>
<td>Option to admit to hospital and insert lumbar CSF drain 24 h preoperatively to avoid issues with traumatic tap and systemic anticoagulation</td>
</tr>
<tr>
<td>Traumatic/bloody tap</td>
<td>Discuss with surgeon, delay anticoagulation at least 60 min, consider delaying surgery 24 h, higher index suspicion postoperative neuraxial hematoma</td>
</tr>
<tr>
<td>Hemodynamics</td>
<td>Avoid hypotension, MAP to maintain SCPP&gt;60 mm Hg, avoid large increases in CVP</td>
</tr>
<tr>
<td>Zero transducer</td>
<td>Phlebostatic axis to ensure accurate calculation of SCPP</td>
</tr>
<tr>
<td>CSF drainage</td>
<td>CSFP &lt;10 mm Hg or to maintain SCPP &gt;60 mm Hg, no more than 10–15 mL/h CSF drainage, intermittent drainage with continuous monitoring preferred to allow calculation of SCPP and avoid large volumes CSF drainage</td>
</tr>
<tr>
<td>Subarachnoid opiates</td>
<td>Avoid, may exacerbate spinal cord ischemia</td>
</tr>
<tr>
<td>Hemodynamics</td>
<td>Avoid hypotension</td>
</tr>
<tr>
<td>Duration of drainage/monitoring</td>
<td>Avoid prolonged drainage to minimize infection risk, consider keeping drain in place&lt;72 h</td>
</tr>
<tr>
<td>Bloody CSF drainage</td>
<td>May indicate ICH, consider imaging brain</td>
</tr>
<tr>
<td>New-onset lower extremity neurology</td>
<td>Worsening spinal cord ischemia vs neuraxial hematoma, increase SCPP (increase MAP, decrease CSFP), consider imaging neuraxis.</td>
</tr>
<tr>
<td>Coagulation for drain removal</td>
<td>Platelet count &gt;100 103/L3, INR &lt;1.3, normal aPTT delay removal 2–4 h after last heparin dose, hold heparin 1 h after catheter removal.</td>
</tr>
</tbody>
</table>
Lactate.
Anaerobic metabolism, Non specific to symptoms, easy to measure, CSF vs Blood

S100B.
Soluble astrocyte protein, leaks on cell damage
Increases all patients with surgical trauma.
Elevated 6 hours post clamp.

Glial fibrillary acidic protein (GFAP).
Structural astrocyte protein, reflects apoptosis
Biggest increase all biomarkers. Increases next day, plus before or in parallel to onset of delayed symptoms.
CSF lactate median concentration at T1 (immediately after the catheter positioning, just before skin incision), T2 (15 minutes after clamping), T3 (just before unclamping), T4 (end of surgery), and T5 (4 hours after the end of surgery).

N=16
Patients with SCI have significant CSF lactate differences at T1, T2 and T3.
Evoked potentials: Motor and Sensory

MEP
Motor anterior spinal cord tracts
Can respond more rapidly
Requires TIVA, abolished by volatiles and NMB
Hypothermia

- DHCA
- Epidural
- 4°C isotonic saline instilled into CSF drain
- New drains?
- Systemic
  - May be achieved with patient cooled to 33°C
- No clear evidence
Pharmacological Strategies

- **Opiates**
  - CSF opioids exacerbate SCI
  - Intrathecal $\mu$ and $\delta$ agonists
  - IV naloxone used in some centres routinely

- **$\alpha_2$ agonists**
  - Dexmedetomidine/Clonidine
## Pharmacological Strategies

<table>
<thead>
<tr>
<th>Anti inflammatory</th>
<th>Antioxidant</th>
<th>Anti excitatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steroids</td>
<td>Melatonin</td>
<td>MgSO4</td>
</tr>
<tr>
<td>Erythropoietin</td>
<td>N Acetylcysteine</td>
<td>Anti glutamate (riluzole)</td>
</tr>
<tr>
<td>Statins</td>
<td>Mannitol</td>
<td>Carbamazepine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thiopentone</td>
</tr>
</tbody>
</table>
Ischaemic preconditioning

Volatile agents and non injury ischaemia
Large trials warranted

- 40 adult patients
- Remote upper limb ischaemia: 3 cycles of 5min upper limb ischaemia, followed by 5min reperfusion.
- Beneficial spinal cord effects

Hu S et al, J NeuroSurg Anesthiol 2010 Apr 22(2) 157
Summary

- **Preserve spinal cord blood supply:**
  Staged, PPG, branch hypogastric, Lsubclavian revascularisation

- **Increase ischaemic tolerance:**
  Hypothermia, Epidural cooling, pharmacological

- **Optimise spinal cord perfusion:**
  MAP, CSFD, Avoid steal, embolism

- **Early detection:**
  Intraop MEP/SSEP, biochemical tests, early neuro assessment.