2012-03-24

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Paraplegia Following Pneumonectomy and Descending Thoracic Aorta Mass Resection
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Background
We present a case of paraplegia following an emergent resection of a lung mass with thoracic aortic involvement. This complex case poses the opportunity to discuss several perioperative issues.

Fluid management for pneumonectomy:
Pneumonectomy has a high 30-day mortality rate, with incidences reaching 20%.1 Acute lung injury (ALI) is a major predictor of mortality in pneumonectomy.2 Clinical data suggest that IV fluids >4L within the first 24 hours can contribute to the development of ALI.3 As a result, conservative fluid management is recommended.

Fluid management for thoracic aorta cross-clamping:
Endoaneurysm in the setting of aortic cross clamping is minimized by adequate circulating volume and perfusion pressure, which are maintained by administration of ample IV fluids.

Spinal cord ischemia (SCI): SCI is a devastating complication of surgical repair of the thoracic aorta. The incidence of SCI with surgical repair of the thoracic aorta has been reported to be as high as 14%, and thoracoabdominal anastomosis has an estimated SCI incidence of 0.02%.4,5 SCI may present with lower extremity weakness ranging from paraparesis to paraplegia. Moreover, clinical onset of SCI may be immediate or as late as months after the surgery. Prevention of SCI and neurological deficits is not only important in ensuring a better quality of life but also in improving the survival rate.6-8

Spinal Cord Ischemic Threat Prevention & Management

<table>
<thead>
<tr>
<th>Spinal Cord Ischemic Threat</th>
<th>Intervention</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arterial Crossclamp Perfusion</td>
<td>Improvement of arterial perfusion pressure</td>
<td>Minimize arterial crossclamp time, increase MAP</td>
</tr>
<tr>
<td>Suppression of arterial metabolism</td>
<td>Moderate hypothermia (34°C)</td>
<td>Precool the patient before surgery</td>
</tr>
<tr>
<td>Pharmacological neuro-protection of spinal cord</td>
<td>Intravenous bolus of mannitol, rabeprazole, propofol,</td>
<td>Immediately before crossclamp application</td>
</tr>
<tr>
<td>Prevention of steal from collateral arterial network during aortic crossclamping and reopening of aorta</td>
<td>Administered sodium bicarbonate</td>
<td>Interrupted crossclamp application</td>
</tr>
<tr>
<td>Early detection and intervention of SCI</td>
<td>Intraoperative monitoring of somatosensory evoked potentials and motor evoked potentials</td>
<td>Immediate re-exploration and revascularization</td>
</tr>
</tbody>
</table>

Peri-Operative Timeline

<table>
<thead>
<tr>
<th>POD</th>
<th>Neurologic</th>
<th>Pulmonary</th>
<th>Renal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>• FirstOperation: Flexible bronchoscopy, mediastinoscopy, left thoracotomy, mass noted to be adherent to descending thoracic aorta. Procedure aborted.</td>
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<tr>
<td>1-2</td>
<td>•Exam unchanged •Nephrotoxicity not for MAP goal &gt; 100 mmHg •CSFDreplaced with 100 mmHg and set to drain for CSF pressure &gt; 10 mmHg</td>
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<tr>
<td>3-4</td>
<td>•Exam unchanged •Nephrotoxicity not for MAP goal &gt; 100 mmHg •CSFDreplaced with 100 mmHg and set to drain for CSF pressure &gt; 10 mmHg</td>
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</tr>
<tr>
<td>5-6</td>
<td>•Exam unchanged •DIC nonparenchymal on POD 5.5 •CSFDremoved on POD 5 •MVr throracic-lumbosacral aorta on POD 5 concerning for thoracic cord infarction</td>
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</tr>
<tr>
<td>7-DC</td>
<td>•Exam unchanged •Discharged to Rehab on POD 10.5</td>
<td>•Exam unchanged •Discharged to Rehab on POD 10.5</td>
<td>•Exam unchanged •Discharged to Rehab on POD 10.5</td>
</tr>
<tr>
<td>Follow-up</td>
<td>•Video to take a few steps with the aid of a walker</td>
<td>•Video to take a few steps with the aid of a walker</td>
<td>•Video to take a few steps with the aid of a walker</td>
</tr>
</tbody>
</table>

Discussion
The major intraoperative challenge of this case was the conflicting goals in fluid management for concomitant pneumonectomy and thoracic aorta resection. A conservative approach was taken to fluid management. Although it is difficult to be certain, low-normal intravascular volume and hypotension around the time of aortic clamping and release may have contributed to renal injury and SCI. Conversely, the patient’s favorable post-operative pulmonary function may have been attributable, at least in part, to the conservative fluid strategy.

Continued fluid management decisions in the setting of recent pneumonectomy and acute kidney injury posed a postoperative challenge. The incidences of renal failure related to thoracic surgery as high as 15%.9,10 Indeed, this patient developed postoperative ATN. Intraoperative volume maintenance is thought to reduce the risk of kidney injury. In the ICU, this patient was given maintenance IV fluids and intermittent post-operative oliguria was treated with colloid infusions in order to strike a balance between conservative fluid management for optimal pulmonary function and aggressive fluid administration aimed at minimizing any further renal injury. Urine output was maintained and renal function returned without need for dialysis.

The incidences of SCI with surgical repair of the thoracic aorta may be up to 14%.2,9 Maintenance of adequate mean arterial pressure, and thus SCI perfusion pressure, is paramount in limiting SCI. Typically, first-line management for maintenance of MAP is fluid administration, then vasoconstrictors. As discussed above, aggressive IV fluids were avoided; thus, vasoconstrictors were used for isolated blood pressure goals. Furthermore, we chose CSF drainage for additional SCI treatment as this combination was felt to be the most evidence-based approach of the SCI therapies described in the literature.

References

Abbreviations
ALI: Acute Lung Injury; ATN: Acute Tubular Necrosis; CSFD: Cerebrospinal Fluid Drain; GETA: General Endotracheal Anesthesia; Gtt: Drop; I&O: In and Output; IS: Incentive Spirometry; LA: Local Anesthetic; LE: Lower Extremity; LPM: Liter Per Minute; MAP: Mean Arterial Pressure; PF/DF: Plantar Flexion/Dorsiflexion; POD: Post-Operative Day; SC: Spinal Cord; SCI: Spinal Cord Ischemia; UO: Urine Output

Figure 1. CXR prior to 2nd operation: Note left hilar mass.

Figure 2. Creatinine trend over peri-operative period.