INTRODUCTION

Spinal cord ischemia (SCI) after TEVAR in TBAD was reported as one of major complications.

- Reported incidence ranged from 2% to 10%
- Defined as newly-developed lower extremity motor and sensory deficits, with or without gatism
- It is multi-factorial and mechanism is complicated.

Data from single center

- 1217 TEVAR cases for TBAD or PAU/IMH
- 13 (1.06%) cases of symptomatic SCI
  - 7 cases onset 24-72h after TEVAR
  - 6 cases before TEVAR
  - 7 cases after TEVAR

Screening of TEVAR-related SCI predictors

Demographics and Comorbidity: One year data (2011-2012)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Paraplegia Group</th>
<th>Paraplegia Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age(years)</td>
<td>52.28 ± 16.52</td>
<td>60.25 ± 16.183</td>
<td>0.225</td>
</tr>
<tr>
<td>Cardiac disease</td>
<td>2.21 (10.9)</td>
<td>1 (25)</td>
<td>0.199</td>
</tr>
<tr>
<td>Diabetes</td>
<td>6 (3.6)</td>
<td>1 (25)</td>
<td>0.001</td>
</tr>
<tr>
<td>Hypertension</td>
<td>17 (93.6)</td>
<td>4 (100)</td>
<td>0.035</td>
</tr>
<tr>
<td>Intracranial disease</td>
<td>11 (5.5)</td>
<td>3 (75)</td>
<td>0.321</td>
</tr>
<tr>
<td>Lung disease</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0.431</td>
</tr>
<tr>
<td>Renal dysfunction</td>
<td>7 (4.3)</td>
<td>5 (75)</td>
<td>0.431</td>
</tr>
<tr>
<td>Smoke</td>
<td>90 (43.6)</td>
<td>0 (0)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Screening of TEVAR-related SCI predictors

- Aortic coverage length
- Rapid thrombosis in false lumen
- Regional anatomy of spinal cord blood supply
- Perioperative hypotension
- Previous aortic surgery or EVAR in 1 stage
  - ……
Factor 1: Length of stent-graft coverage

**Theoretically, the longer coverage with stent-graft, the higher risk of SCI happens.**

The site of entry tear should be located and covered with stent-grafts accurately.
- Customized short stent-graft
- Precise positioning
- Avoid coverage of thoracic segment

**BUT…**

NOT all longer coverage taking high possibility of paraplegia.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Paraplegia Group</th>
<th>Paraplegia Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare stent implantation</td>
<td>30(14.5)</td>
<td>1(25)</td>
<td>0.337</td>
</tr>
<tr>
<td>Chimney technique</td>
<td>26(12.7)</td>
<td>0(0)</td>
<td>0.084</td>
</tr>
<tr>
<td>Aortic coverage length(mm)</td>
<td>167.98 ± 17.60</td>
<td>177.75 ± 22.72</td>
<td>0.339</td>
</tr>
<tr>
<td>Distal uncovered length(mm)</td>
<td>78.44 ± 38.78</td>
<td>90.50 ± 20.62</td>
<td>0.609</td>
</tr>
<tr>
<td>Lowest MAP&lt;70mmHg</td>
<td>9(4.1)</td>
<td>3(76)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

In our data, coverage length was not significant between paraplegia and non-paraplegia group.

Two tapered stent-grafts were deployed, covered the whole descending aorta from aortic arch to Celiac truck.

No paraplegia happened peri-operation.

All dissection area were covered. During the long-term follow-up, the patient recovered well, no late complication happened.

**Experimental evidence:** higher clamping segmental intercostal arteries without ischemic change in pig

*Shown are studies under various circumstances of the average numbers of segmental arteries—intercostal or lumbar—which could be serially clamped without provoking an ischemic change in the motor evoked potential signals in juvenile pigs.*

Factor 2: Rapid thrombosis in FL

Paraplegia 10 hours after TEVAR
Emergent CTA indicated nice remodeling of descending aorta with completed thrombosis in the false lumen, coverage of the original of the LSA.

Factor 3: Hypotension during deployment

- Anaesthesia record indicated hypotension during TEVAR.
- SBP were lower than 80mmHg during entire procedure.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Non-Paraplegia Group</th>
<th>Paraplegia Group</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare stent implantation</td>
<td>30(14.5)</td>
<td>1(25)</td>
<td>0.337</td>
</tr>
<tr>
<td>Chimney technique</td>
<td>28(12.7)</td>
<td>0(0)</td>
<td>0.084</td>
</tr>
<tr>
<td>Aortic coverage length (mm)</td>
<td>167.98 ± 17.68</td>
<td>177.75 ± 22.2</td>
<td>0.339</td>
</tr>
<tr>
<td>Distal uncovered length (mm)</td>
<td>78.44 ± 38.78</td>
<td>90.50 ± 20.62</td>
<td>0.609</td>
</tr>
<tr>
<td>Lowest MAP &lt; 70mmHg</td>
<td>9(4.1)</td>
<td>3(75)</td>
<td>0.001</td>
</tr>
</tbody>
</table>

Factor 4: Coverage of both LSA and Celiac A.

- Distance between LSA and Celiac
- Preserve at least one, of LSA or Celiac, according to specific tear site
- Keep collateral map of spinal cord blood supply

How to preserve LSA for decreasing SCI?

- Self-modified fenestration
- In situ fenestration
- Chimney insertion
- Branched stent-graft

The patient, 46 years old, male suffered from chest pain for 6 days. CTA indicated a type B aortic dissection, the LSA was invaded by the primary entry tear, long extended dissection, left-dominant vertebral artery.
The aortic stent-graft was deployed, covering the origin of LSA. Then puncture the fabric with a stiff guide wire.

**In Situ Fenestration**

**Chimney**

**Branched Stent-graft**

Factor 5: Regional anatomy of spinal cord blood supply

- If most intercostal arteries were supplied by the false lumen, after TEVAR, retrograde flow from distal may keep perfuse intercostal A.
- If most intercostal arteries originated from true lumen, after TEVAR, more SCI risk.

**Unique mechanism for aortic dissection**

**Tip 1: Peri-operative MAP control**

- Adjust arterial blood pressure by vasopressor and volume expansion
- MAP > 70mmHg should be maintained if SCI occurred
- Strict monitoring of permissive BP control

What can we do to prevent SCI during or after TEVAR?
Tip 2: CSF drainage

Perfusion pressure = arterial pressure – intracranial pressure

- Effective way to reverse paraplegia after TEVAR
- NOT necessary to perform prophylactic CSF drainage
- CSF drainage should be proceeded ASAP if paraplegia
- Monitoring Intracranial pressure < 150mmH\(_2\)O

Tip 3: Comprehensive medical treatment

- Steroid therapy
- Anticoagulation – LMWH
- Dehydration – Mannitol
- Neurotrophy
- Vasodilator
- Functional training and exercises
- High pressure oxygen

Tip 4: Staged operation if both TEVAR and EVAR are needed for entire pathologies

The patient, male, suffered from acute aortic dissection when he was 35 years old in 2005. The dissection invaded descending and abdominal aorta. So, staged endovascular treatment was planned, TEVAR for primary tear is first step.

Abdominal aortic dissecting aneurysm keeps enlarged, EVAR was performed in secondary stage.

Tip 4: Staged operation if both TEVAR and EVAR are needed for entire pathologies

All dissection tears were covered in staged procedures, no paraplegia after TEVAR+EVAR.

SUMMARY

- Mechanism of postoperative paraplegia appears to be multi-factorial, hypotension could be independent risk factor of paraplegia after TEVAR.
- Regional anatomy of AKA is also important reason for paraplegia.
- Management of SCI should be early and aggressive.
- Staged operation or LSA preservation may be useful.
THANK YOU!