Risk factors for postoperative cerebrospinal fluid leakage associated with total en bloc spondylectomy


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Cerebrospinal fluid (CSF) leakage is a serious postoperative complication associated with spine surgery. CSF leakage can lead to surgical site infection, pyogenic meningitis, intracranial hypotension, and prolonged hospitalization. In total en bloc spondylectomy (TES), the dura mater is dissected circumferentially. Therefore, great care must be taken to prevent CSF leakage after TES. However, compared to general spine surgery, the incidence of postoperative CSF leakage after TES tends to be high.

In this study, we examined the incidence and risk factors for CSF leakage after TES.
Patients and Methods

Subjects of this study

TES surgery: 73 patients
- Between May 2010 and April 2013
- By the same surgeon

exclude 1 patient
with osteosarcoma who underwent TES with transection of the spinal cord owing to tumor invasion.

72 patients
- 39 men and 33 women
- mean age of 53.5 years (range, 16–75 years)
Patients and Methods

Evaluation items

1. Incidence of postoperative CSF leakage
   
   Postoperative CSF leakage: ≥ 250 mL/day of serous drainage after postoperative day 5

2. Risk factors for postoperative CSF leakage

   We examined the association between postoperative CSF leakage and the following parameters:
   
   age, sex, smoking history, diabetes, history of radiotherapy at the surgical site, history of chemotherapy, revision surgery, surgical level, surgical approach, number of resected vertebrae, transection of nerve roots, and intraoperative dural injury.

3. Course of treatment for postoperative CSF leakage

   We assessed the course of treatment for CSF leakage in each patient.
1. Incidence of postoperative CSF leakage

17/72 patients (23.6%)
2. Risk factors for postoperative CSF leakage

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>CSF leakage positive</th>
<th>Odds ratio</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 54 years of age</td>
<td>14/40 pts (35.0%)</td>
<td>5.21</td>
<td>0.011</td>
</tr>
<tr>
<td>Female</td>
<td>10/33 pts (30.3%)</td>
<td>1.99</td>
<td>0.219</td>
</tr>
<tr>
<td>Smoking</td>
<td>5/23 pts (21.7%)</td>
<td>0.86</td>
<td>0.798</td>
</tr>
<tr>
<td>Diabetes</td>
<td>4/8 pts (50.0%)</td>
<td>3.92</td>
<td>0.083</td>
</tr>
<tr>
<td>Preoperative radiotherapy</td>
<td>11/22 pts (50.0%)</td>
<td>7.33</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Preoperative chemotherapy</td>
<td>8/38 pts (21.1%)</td>
<td>0.74</td>
<td>0.589</td>
</tr>
<tr>
<td>Revision surgery</td>
<td>3/7 pts (25.0%)</td>
<td>2.73</td>
<td>0.207</td>
</tr>
<tr>
<td>Lumbar level</td>
<td>5/17 pts (29.4%)</td>
<td>1.49</td>
<td>0.365</td>
</tr>
<tr>
<td>Anterior &amp; posterior approach</td>
<td>4/13 pts (30.8%)</td>
<td>1.57</td>
<td>0.364</td>
</tr>
<tr>
<td>≥ 3 vertebral bodies resection</td>
<td>8/17 pts (47.1%)</td>
<td>4.54</td>
<td>0.014</td>
</tr>
<tr>
<td>Transection of nerve roots</td>
<td>14/61 pts (23.0%)</td>
<td>0.79</td>
<td>0.510</td>
</tr>
<tr>
<td>Intraoperative dural injury</td>
<td>5/6 pts (83.3%)</td>
<td>22.50</td>
<td>0.002</td>
</tr>
</tbody>
</table>
### 2. Risk factors for postoperative CSF leakage

Statistical analysis

- Chi-square test, Fisher’s exact test, binomial logistic regression analysis
- \( P \text{ value} < 0.05 \): statistically significant
- SPSS statistical software version 19 (SPSS, Inc, Chicago, Illinois)

#### Multivariable Analysis of the Risk Factors

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>SE</th>
<th>Significant probability</th>
<th>Exp(B)</th>
<th>95.0% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over 54 years of age</td>
<td>0.80</td>
<td>0.150</td>
<td>3.18</td>
<td>0.66—15.34</td>
</tr>
<tr>
<td>Female</td>
<td>0.82</td>
<td>0.264</td>
<td>2.49</td>
<td>0.50—12.33</td>
</tr>
<tr>
<td>Diabetes</td>
<td>1.05</td>
<td>0.292</td>
<td>3.03</td>
<td>0.39—23.83</td>
</tr>
<tr>
<td>Preoperative radiotherapy</td>
<td>0.83</td>
<td>0.046</td>
<td>5.22</td>
<td>1.03—26.45</td>
</tr>
<tr>
<td>Revision surgery</td>
<td>1.37</td>
<td>0.724</td>
<td>1.62</td>
<td>0.11—23.91</td>
</tr>
<tr>
<td>( \geq 3 ) vertebral bodies resection</td>
<td>0.77</td>
<td>0.091</td>
<td>3.65</td>
<td>0.81—16.39</td>
</tr>
<tr>
<td>Intraoperative dural injury</td>
<td>1.82</td>
<td>0.283</td>
<td>7.08</td>
<td>0.20—251.75</td>
</tr>
</tbody>
</table>
Results

3. Course of treatment for postoperative CSF leakage

All 17 patients of postoperative CSF leakage were treated with:

- Natural drainage by gravity
- Intravenous administration of factor XIII concentrate (24 mL/day × 5 days)
- Implementation of a spinal drainage system as necessary

14 recovered without further complications
3 required reoperation

All 3 patients who required reoperation had a history of irradiation at the surgical site.
A 68-year-old woman with metastatic thyroid cancer at C7-T2

She had a history of irradiation at the surgical site 3 years prior to surgery (56 Gy).

A: She underwent TES via a posterior-only approach.

B: Severe pleural effusion occurred in conjunction with intractable postoperative CSF leakage.

C: Severe pneumocephalus was secondary to intracranial hypotension induced by the connection between the spinal and thoracic cavities.
A 61-year-old man with metastatic gastric cancer at L4

He had a history of irradiation at the surgical site 2 months prior to surgery (30 Gy).

A: He underwent TES via a combined anterior and posterior approach. Postoperative CSF leakage was resistant to conservative treatment.

B: During the reoperation, dural injuries were not clearly observed, but the dural sac was enlarged and CSF oozed from an unidentifiable location.
Discussion

**Risk factors for postoperative CSF leakage associated with TES**

① Aging
- Aging-related structural changes in the dura mater may account for the increased dural permeability.
  

② ≥ 3 vertebral bodies resection
- Elevated surgical invasiveness is a significant risk factor for dural injury.
  
  —Baker et al. Spine J, 2012

③ Radiation — strong risk factor!! —
- Radiation-induced fibrosis results in adhesion between tissues and can cause dural injury during surgery.
- Changes in the structure of the dura mater itself, such as weakening or increased permeability, may occur, as illustrated in case 2.
Postoperative CSF leakage associated with total en bloc spondylectomy is a frequent complication. Preoperative irradiation at the surgical site is a strong risk factor for postoperative CSF leakage; furthermore, its treatment tends to be time consuming.

The authors declare that they have no conflict of interests.