Fluoroscopically guided epidural blood patch with subsequent spinal CT scans in the treatment of spontaneous cerebrospinal fluid hypovolemia

Technical note

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Object. Recent evidence has indicated that the efficacy of the epidural blood patch (EBP) in the treatment of spontaneous CSF hypovolemia (SCH) is still limited. Therefore, further improvement of the EBP technique is an important clinical challenge. The authors describe a series of cases of SCH treated with fluoroscopically guided placement of an EBP and followed up with subsequent spinal CT scans.

Methods. Thirteen patients with SCH that was proven on CT myelography studies underwent epidural puncture under fluoroscopic guidance and received an injection of a mixture of contrast medium and autologous blood. Contrast medium was injected to cover the area of CSF leakage during EBP guided by fluoroscopy, and the spread of the blood was subsequently evaluated using spinal CT scanning. If the amount of blood injected was insufficient to cover the leakage area, a second EBP was performed at a later date.

Results. At the first EBP procedure, a mixture with a mean volume of 9.4 ml (range 3–20 ml) was injected, and subsequent spinal CT scans revealed contrast enhancement in the desired epidural space in 12 of 13 patients. In 2 patients, a second EBP was required because of insufficient coverage of the leakage area or delayed recurrence of headache. In all patients, a complete recovery from orthostatic headache was obtained after the last EBP.

Conclusions. The results indicated that fluoroscopically guided EBP and subsequent spinal CT scans may provide a highly effective therapy in patients with SCH proven on CT myelography studies.

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Key Words • spontaneous cerebrospinal fluid hypovolemia • computed tomography myelography • fluoroscopic guidance • epidural blood patch

Spontaneous CSF hypovolemia is a condition characterized by the leakage of CSF from a weakened site of the spinal dura mater without a triggering cause such as lumbar puncture. The chief complaint is orthostatic headache, which is caused by brain sag due to a decrease in CSF. The initial treatment for SCH consists of bed rest and intravenous fluid therapy, and, if this is ineffective, an EBP is performed as the most important nonsurgical management.

The EBP procedures are broadly classified into 2 categories: a blind EBP involving lumbar puncture regardless of the site of CSF leakage, or a targeted EBP involving identification of the site of CSF leakage and dural puncture at that site. So far there has been no consensus on which procedure would be preferable. According to the previous studies, EBP in the treatment of SCH seems not to be reliable, with an effectiveness rate of 35%–77%. To improve the effectiveness of EBP, several techniques, including a targeted EBP with a CT or fluoroscopic guide, and a blind EBP with the patient in the Trendelenburg position have been reported. However, the data on such techniques are still limited. Therefore, the data on further improvement of EBP technique in the management of SCH would be of clinical importance.

We assumed that the complete coverage of the areas of CSF leakage with autologous blood would increase the effectiveness of EBP. For that purpose, a mixture of autologous blood and contrast medium was injected to cover the area of CSF leakage during fluoroscopically guided EBP, and the spread of the blood was subsequently evaluated by spinal CT scanning. We describe a series of 13 cases with SCH treated with fluoroscopically guided EBP and monitored with subsequent spinal CT scans.

Methods

We studied 13 consecutive patients with SCH who
had orthostatic headaches unrelieved after more than 2 weeks of bed rest and intravenous fluid therapy, who had been referred to us for evaluation and fluid therapy between August 2006 and December 2009. They consisted of 5 men and 8 women, with a mean age of 37.7 ± 6 years. (The means are expressed ± SD throughout.) Of the 13 patients, 12 had no prior history of trauma, and 1 had a history of a traffic accident injury. All patients had orthostatic headache, 8 had aural fullness and acoustic hyperesthesia, and 7 had nausea. Brain MR imaging studies showed diffuse pachymeningeal Gd enhancement in 12 of the 13 patients, brain sag in 8 patients, and narrowing of the pontine cistern in 11 patients. In 5 patients subdural hematoma was a complication during the clinical course.

On admission, CT myelography was performed with an injection of 10 ml iohexol, and if a CSF leak was detected, EBP was performed within 3 days. The CT myelography finding of contrast medium accumulation in the epidural space was interpreted as a CSF leakage area.

Epidural puncture for the blood patch was performed at the intervertebral level for ease of puncture within the area of contrast medium accumulation (CSF leakage area). The EBP procedure was performed using fluoroscopy with the patient prone, and 1 ml of contrast medium (iohexol) was injected to confirm epidural spread. Under fluoroscopic guidance, a 4:1 mixture of autologous blood and contrast medium was injected to cover the area of contrast medium accumulation. However, when patients complained of a feeling of pressure in the back, the injection was discontinued. Ten minutes after EBP procedure, spinal CT scanning was performed to evaluate the spread of the contrast medium and autologous blood. If the amount of blood injected was insufficient to cover the leakage area and the symptoms remained, a second EBP was performed to cover the remaining uncovered epidural space at a later date.

After EBP, the patient was kept on bed rest in the supine position for 2 hours, and then was allowed to adopt a sitting position until the following day and to walk on the 2nd day. If no side effects were noted, the patient was allowed to leave the hospital on or after the 4th day. One month later, the patient was reexamined for any symptoms of SCH, and underwent Gd-enhanced brain MR imaging again.

Results

Treatment and Outcome

The mean time from the onset of symptoms to the first EBP was 42.9 ± 26 days. All patients had areas of CSF leakage (epidural accumulation of contrast medium) in CT myelography, and the ranges of accumulation area were from upper cervical to lumbar levels in 3 patients (C2–L2, C1–L4, and C1–L1); from upper cervical to lower thoracic levels in 4 patients (C2–T10, C3–T9, C2–T9, and C2–T11); from cervical to upper thoracic levels in 4 patients (C6–T2, C2–T2, C6–T4, and C2–T1); and at only thoracic levels in 2 patients (T1–8 and T2–8). The prolonged enhancement of the nerve root sleeves were observed at the multiple cervicothoracic levels in 10 patients, and in 5 of 10 patients the accumulation of contrast medium was at the C-2 level region. They underwent epidural puncture at the T1/2 or C7/T1 level. The epidural space was identified using the loss-of-resistance method. The initial injection of contrast medium was done intravascularly with the aid of real-time fluoroscopy in 3 patients, who underwent epidural puncture of another intervertebral level. The mean volume of the mixture injected was 9.4 ± 4.5 ml (range 3–20 ml). The spinal CT after the first EBP revealed contrast enhancement in the desired epidural space in 12 of 13 patients (Table 1).

After the first EBP, orthostatic headache persisted in 1 patient who had the insufficient spread of blood in the spinal CT after the EBP. She had an area of leakage at the C1–L4 level, and blood spread was at C1–T7. The EBP was performed again at the T11/12 level 1 week later, 17 ml of the mixture was injected, and blood spread was seen at the C2–L4 level in the second spinal CT. The remaining patient had a massive CSF leak requiring 2 EBPs. The spinal CT after the first EBP showed that the CSF leakage area was completely covered with blood, and the orthostatic headache disappeared completely, but mild auricular fullness persisted. The patient was discharged, but Gd-enhanced MR imaging obtained 1 month later showed persistent dural thickening. Thus, the patient was readmitted and underwent CT myelography, which showed a persistent CSF leak into the epidural space. A second EBP was performed by injecting 23 ml of the mixture at the T1/2 level.

In all patients orthostatic headache was relieved within 3 days after the last EBP, and they became completely asymptomatic 1 month later. Gd-enhanced brain MR imaging studies obtained 1 month after the last EBP showed the improvement of preoperative dural thickening.

Postoperative Complications

The influx of autologous blood into the subarachnoid space occurred as a complication of the second EBP in 1 patient, who complained of palpitation and nausea during blood injection, and of mild headache for 3 days. Because 3 patients complained of back pain, a severe feeling of pressure, and respiratory discomfort during blood injection, EBP was terminated early. In these 3 patients, the spinal CT scans obtained after the EBP showed that the injection of 6, 4, or 3 ml of blood achieved sufficient blood spread, and their symptoms improved. The other 4 patients complained of a mild feeling of pressure in the back and pain at the puncture site, which improved within 3 days.

Illustrative Case

This 34-year-old woman experienced sudden-onset headache and nausea in the morning, underwent Gd-enhanced brain MR imaging, which showed dural thickening and brain sag, leading to a diagnosis of SCH. She received intravenous fluid therapy, and showed symptom relief. However, since the orthostatic headache and aural fullness remained, she was scheduled for EBP. She was admitted on the 62nd day after the onset of illness, and underwent CT myelography on the 65th day. The initial
Epidural blood patch for cerebrospinal fluid hypovolemia

CSF pressure was 0 mm Hg, and CT myelography visualized the C5–7 nerve roots extending into the extravertebral space, and revealed the accumulation of contrast medium in the epidural space at the C2–T10 levels. On the 66th day, epidural puncture for EBP was performed at the T1/2 level. Fluoroscopic findings during the EBP indicated that spread of the mixture was obtained from the C-2 to upper thoracic level with an 8-ml injection of mixture (Fig. 1). A subsequent spinal CT scan revealed that the spread of blood was ranging from the C-2 to T-10 levels. Although bed rest was discontinued on the 69th day, her orthostatic headache disappeared. On the 109th day, CT myelography was performed again, which showed the complete disappearance of the CSF leak (Fig. 2), and Gd-enhanced brain MR imaging findings were also improved.

**Discussion**

The results in a series of 13 patients with SCH proven on CT myelography studies showed that at the first fluoroscopically guided EBP, a mixture with a mean volume of 9.4 ml was injected and subsequent spinal CT scans revealed contrast enhancement in the desired epidural space in 12 of 13 patients. In 2 patients, the second EBP was required because of insufficient coverage of the area of leakage or delayed recurrence of headache. In all patients, a complete recovery of orthostatic headache was obtained within 3 days after the last EBP. These suggest that fluoroscopically guided EBP and subsequent spinal CT scans achieved a very high rate of efficacy in patients with SCH, in which a CSF leakage area was detected on CT myelography.

It has been suggested that EBP triggers an aseptic inflammation that seals the CSF leaks, and therefore, epidural blood should be placed at the exact site of the CSF leak. Because it has been reported that the majority of CSF leaks were found at the cervicothoracic junction, the choice of target EBP may be reasonable compared with that of a blind EBP involving lumbar puncture. In the present study, the CSF leakage sites were suspected at the cervical or thoracic level in all patients, and we selected the target EBP involving the puncture at the levels of CSF leaks identified using fluoroscopy.

There are several advantages of using fluoroscopically guided EBP. First, fluoroscopy makes the epidural puncture easy by visualizing the interspinous space enclosed by vertebral lamina and articular process, and the direction of the needle insertion. Second, the epidural space can be identified by the administration of contrast medium. Accidental dural puncture has been reported to occur in 0.6%–3% of patients during epidural anesthesia. Because EBP is almost the same procedure as epidural anesthesia, there is a risk of dural puncture. There

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**TABLE 1: Clinical characteristics of 13 patients with EBPs**

<table>
<thead>
<tr>
<th>Age (yrs), Age (yrs), Sex</th>
<th>Time to EBP (days)</th>
<th>Area of Epidurogram on CTM</th>
<th>Puncture Site</th>
<th>Vol of Mixture in ml</th>
<th>Area of Epidurogram in EBP</th>
<th>Complications</th>
<th>Pain Relief</th>
</tr>
</thead>
<tbody>
<tr>
<td>29, M</td>
<td>17</td>
<td>T1–8</td>
<td>T1/2</td>
<td>3</td>
<td>C7–T7</td>
<td>respiratory discomfort</td>
<td>yes</td>
</tr>
<tr>
<td>38, F</td>
<td>92</td>
<td>C6–T2</td>
<td>C7/T1</td>
<td>4</td>
<td>C4–T2</td>
<td>intravascular injection, severe feeling of pressure</td>
<td>yes</td>
</tr>
<tr>
<td>34, M</td>
<td>87</td>
<td>C2–T2</td>
<td>C7/T1</td>
<td>6</td>
<td>C2–T2</td>
<td>intravascular injection, back pain w/ injection</td>
<td>yes</td>
</tr>
<tr>
<td>39, F</td>
<td>37</td>
<td>C6–T4</td>
<td>C7/T1</td>
<td>7</td>
<td>C2–T10</td>
<td>no complaint</td>
<td>yes</td>
</tr>
<tr>
<td>33, F</td>
<td>45</td>
<td>C2–T1</td>
<td>T1/2</td>
<td>7</td>
<td>C2–T2</td>
<td>mild feeling of pressure</td>
<td>yes</td>
</tr>
<tr>
<td>34, F</td>
<td>66</td>
<td>C2–T10</td>
<td>T1/2</td>
<td>8</td>
<td>C2–T10</td>
<td>no complaint</td>
<td>yes</td>
</tr>
<tr>
<td>53, F</td>
<td>21</td>
<td>T2–8</td>
<td>T1/2</td>
<td>9</td>
<td>C2–T6</td>
<td>no complaint</td>
<td>yes</td>
</tr>
<tr>
<td>38, M</td>
<td>30</td>
<td>C2–L2</td>
<td>T1/2</td>
<td>10</td>
<td>C2–L2</td>
<td>mild feeling of pressure</td>
<td>yes</td>
</tr>
<tr>
<td>45, F</td>
<td>30</td>
<td>C3–T9</td>
<td>T1/2</td>
<td>11</td>
<td>C2–T11</td>
<td>no complaint</td>
<td>yes</td>
</tr>
<tr>
<td>40, M</td>
<td>70</td>
<td>C2–T9</td>
<td>T1/2</td>
<td>11</td>
<td>C2–T10</td>
<td>intravascular injection, mild feeling of pressure</td>
<td>yes</td>
</tr>
<tr>
<td>35, M</td>
<td>20</td>
<td>C2–T11</td>
<td>T1/2</td>
<td>15</td>
<td>C2–T11</td>
<td>mild feeling of pressure</td>
<td>yes</td>
</tr>
<tr>
<td>35, F</td>
<td>22</td>
<td>C1–L4</td>
<td>T1/2 (T11/12)</td>
<td>11 (17)</td>
<td>C1–T7 (C2–L4)</td>
<td>no complaint (no complaint)</td>
<td>no (yes)</td>
</tr>
<tr>
<td>37, F</td>
<td>27</td>
<td>C1–L1</td>
<td>T1/2 (T1/2)</td>
<td>20 (23)</td>
<td>C1–L3 (C1–L4)</td>
<td>no complaint (intrathecal injection)</td>
<td>no (yes)</td>
</tr>
</tbody>
</table>

* Data in parentheses are findings of the second EBP. Abbreviation: CTM = CT myelography.
have been several reports on intrathecal injection of autologous blood and subdural hematoma. From a safety standpoint, identification of the epidural space is the most critical part of an EBP placement. Furthermore, without the identification of epidural space, autologous blood may be administered in the superficial layers above the epidural space. Therefore, we confirm that contrast medium is injected into the epidural space by visualizing not only on the anteroposterior view but also on the lateral view under fluoroscopy. Finally, by the administration of a mixture of autologous blood and contrast medium under fluoroscopy, the spread of contrast can be evaluated, and the amount of blood can be titrated to cover the leakage area. According to previous reports, 15–40 ml for blind EBP and 5–20 ml for targeted EBP has been recommended as a volume of blood. In the present study, the mean volume of the mixture injected was 9.4 ml, and in several cases, the volume of 3–6 ml was enough to treat SCH.

In this study, we believe that the CT myelography findings of accumulation in epidural space were important for the target of EBP. However, CT myelography showed other findings, including the prolonged enhancement of the root sleeves in 10 patients and accumulation at the C-2 region in 5 of 10. In the present study we didn’t assume that these findings identified the focal sites of leakage, because the findings may not always be caused by tears of the dura mater at that site. In the previous report of surgical findings, a massive CSF leak at the C-2 region resulted from the accumulation of CSF that had leaked at the cervicothoracic junction along the epidural space. So, we assume that the tears of the dura are somewhere in the area of the epidural space showing contrast medium accumulation, and if the area of accumulation can be completely covered by EBP, it is likely that the tears can be treated.

Spinal CT studies after the EBP can provide much valuable information. Fluoroscopic findings provide only long-axis images, but not cross-sectional images. Therefore, we can evaluate whether the epidural space is circumferentially covered with blood, and then confirm the extent of the spread of blood in the epidural space after the EBP procedure. Actually, in 1 case with the leakage area at Cl–L4 levels on pretreatment CT myelography, the puncture of the first EBP was performed at the T1/2 level. Spinal CT scans obtained after the EBP showed that the spread of blood was insufficient to cover the lumbar area, and orthostatic headache was not relieved. The puncture of the second EBP was performed at T11/12 by reference to the findings on spinal CT scans. The second spinal CT revealed that the lumbar epidural space was covered with autologous blood, and pain relief was achieved. Therefore, the combined use of CT myelography and spinal CT studies after the EBP would be useful to decide whether the second EBP is necessary.

There are several limitations in the present study. First, all patients had typical orthostatic headache. In addition, 12 of them had typical SCH findings, showing dural thickening on Gd-enhanced brain MR imaging. It has been reported that the therapeutic effect of EBP is low in patients without dural thickening on brain MR imaging. It is therefore unknown whether the EBP technique we present is also effective in patients with atypical symptoms and/or without dural thickening on brain MR imaging. It has been also used for diagnosis of SCH, and a CSF leak could be identified in all patients. In other studies, RIC has been able to identify CSF leaks in 70% and 100% of patients, respectively. Therefore, we selected CT myelography for detection of the leakage site in this study. If SCH is diagnosed using RIC without abnormal findings on CT myelography, therapeutic effects of fluoroscopically guided EBP may be different. Finally, in the present study there were no cases with meningeal diverticulum or leakage at only the lumbar site. The efficacy of this EBP technique in such patients is unknown.

Conclusions

We describe a management protocol in 13 patients with CT myelography–proven SCH, who underwent epidural puncture under fluoroscopic guidance and received an injection of a mixture of contrast medium and autologous blood. The spread of the contrast medium was subsequently evaluated on spinal CT scans after the EBP. Although 2 patients required a second EBP, all participants were ultimately cured. These findings suggest that fluoroscopically guided EBP with subsequent spinal CT scanning may provide a highly effective therapy in patients with CT myelography–proven SCH.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Watanabe, Hashizume, Furuya. Acquisition of data: Watanabe, Hashizume, Kawaguchi, Fujiwara, Sasaoka. Analysis and interpretation of data: K. Watanabe et al.
Epidural blood patch for cerebrospinal fluid hypovolemia

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