3D-CT Epidurography Can Detect Cerebrospinal-Fluid Leakage in a Patient with Spontaneous Intracranial Hypotension: A Case Report

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Spontaneous intracranial hypotension presents with many symptoms including orthostatic headache, dizziness, and nausea due to cerebrospinal-fluid (CSF) leakage from the spinal dural sac. Although CSF leakage can be estimated by radioisotope (RI) cisternography or computed tomography/magnetic resonance imaging myelography, it is not easy to detect the leakage point using these modalities. Here, we describe a patient with spontaneous intracranial hypotension in whom three-dimensional computed tomography (3D-CT) performed just after an epidural blood patch (EBP) containing contrast medium detected leakage point. The contrast medium injected into the epidural space at the L3/4 level migrated into the intradural space at the lower cervical spine level. RI cisternography performed before EBP did not show the CSF leakage point or any intracranial extension of the tracer. The rostral extension of the RI may be blocked by the collapse of the CSF space due to a large amount of CSF leakage, and due to the compression of the intradural CSF space by epidural CSF. 3D-CT epidurography may be useful to detect the fistula of a CSF leakage even in patients where other modalities including MRI, CT, or RI cisternography cannot specify the leakage point.

Keywords: spontaneous intracranial hypotension, epidural blood patch, epidurography, three-dimensional computed tomography, cerebrospinal-fluid leakage

Introduction

Spontaneous intracranial hypotension is a pathological condition associated with serious symptoms including headache, dizziness, and nausea that are markedly enhanced by orthostatic stress. The most plausible etiology of these is the decreased intracranial pressure caused by cerebrospinal-fluid (CSF) leakage from the spinal dural sac. Although the terms “intracranial hypotension,” “CSF leakage,” and “CSF hypovolemia” have been regarded as almost synonymous, their differences and relationship have become evident on the basis of neuroradiological findings in patients with this syndrome.1) Diffuse enhancement of a thickened dura mater, which was diffusely enhanced by intravenous gadolinium injection, narrowing of the preoptine cistern, a swelling of the pituitary, and dilated intracranial venous sinuses (Fig. 1). It also revealed thin chronic subdural hematoma in her frontal region. Spinal MRI of lumbar level showed a narrowing of the intra dural space and epidural fluid collection (Fig. 2). On a cervical level, abnormalities were not shown (Fig. 3). In RI cisternography, the tracer injected intrathecaclly via lumbar puncture filled the bladder after only 20 minutes. The tracer did not reach the basal venous plexus in epidural space, descent of the cerebellar tonsil, a flattened brain stem, and pituitary swelling are also valuable for the diagnosis of this condition. CSF leakage from the spinal dural sac can be detected by certain imaging modalities. In radioisotope (RI) cisternography, abnormal RI accumulation in the spinal epidural space, increased clearance of the tracer from the CSF space, or early bladder filling (EBF) of RI are regarded as suggestive of CSF leakage. MRI or MRI/computed tomography (CT) myelography can also identify CSF in the spinal epidural space.3) Although these are valuable modalities to find CSF leakages, it is difficult to detect the leakage point of CSF in patients with spontaneous intracranial hypotension.

In this article, we report a patient with cerebrospinal fluid (CSF) hypovolemia, the leakage of which was not detected by either RI cisternography or MRI, but detected by three-dimensional computed tomography (3D-CT) performed just after the epidural injection of the patient’s own blood, containing a contrast medium. This finding suggests that 3D-CT epidurography may be a useful tool to detect the fistula of CSF leakage, even in patients in whom other modalities including MRI, CT, or RI cisternography cannot specify the leakage point.

Case Report

A 31-year-old female high school teacher with no particular past history was involved in two rear-end collisions 5 years previously. Four years later, she sometimes had headache, these rapidly worsened several weeks before admission. The headache was intractable and uncontrolled by commercially available painkillers, which resulted in her visiting and being admitted to our hospital. She had no specific neurological deficits and no abnormal findings on cranial CT.

In spite of bed rest and sufficient hydration, her headache got worse and was enhanced by the orthostatic stress. MRI examined 24 days after admission showed a thickened dura mater, which was diffusely enhanced by intravenous gadolinium injection, narrowing of the preoptic cistern, a swelling of the pituitary, and dilated intracranial venous sinuses (Fig. 1). It also revealed thin chronic subdural hematoma in her frontal region. Spinal MRI of lumbar level showed a narrowing of the intra dural space and epidural fluid collection (Fig. 2). On a cervical level, abnormalities were not shown (Fig. 3). In RI cisternography, the tracer injected intrathecaclly via lumbar puncture filled the bladder after only 20 minutes. The tracer did not reach the basal...
cistern. The RI clearance from the whole neuraxis was markedly increased (RI residual ratio: 3%) (Fig. 4). This may be based on the leak from a puncture point. But these findings suggested that low intracranial pressure on account of CSF leakage from the spinal dural sac induced chronic subdural hematoma.

An epidural blood patch (EBP) was performed on the 38th hospital day. Thirty milliliters of the patient’s own blood containing 3 ml of iodinated contrast medium was injected into the epidural space between the spinal processes of L3 and L4 (data not shown). Interestingly, whole-spine CT examined immediately after the EBP procedure revealed that the contrast medium injected into the lumbar epidural space ascended to the cervical spine level and migrated into the cervical and cranial subarachnoid spaces. The estimated level of the transition of the contrast medium from the epidural to subarachnoid spaces was around C7 (Fig. 5). These findings strikingly suggested CSF leakage via a fistula of the dural sac around the C7 vertebral level. But axial view did not show clearly leakage point (Fig. 6).

Following EBP, her headache completely improved and her subdural hematoma completely disappeared on cranial CT. Moreover, the extradural fluid had disappeared on a spinal MRI conducted 4 days after the EBP (Fig. 7).
Fig. 6 CT axial image around C7 level after the EBP (a–h, head side to tail side). The contrast medium is both intradural and extradural at this level, but not identified leakage point this view. CT: computed tomography, EBP: epidural blood patch.

The patient was discharged from the hospital with no symptoms or neurological deficits 2 weeks after the EBP. RI cisternography performed 3 months after the EBP showed no early bladder filling and improved RI clearance from the whole neuraxis (RI residual ratio: 24%) (Fig. 8).

Discussion

In the patient reported in this article, MRI showed diffuse enhancement of a thickened cranial dura, narrowing of the preopticine cistern, enlargement of the pituitary gland, and an ectatic venous sinus. These findings suggest an intracranial hypotensive state in the patient. Although the spinal MRI showed narrowing of the intradural space and epidural fluid collection, it did not show direct evidence of the CSF leakage point. RI cisternography was also unable to detect the CSF leakage point, although it showed early bladder filling and increased radionuclide clearance from the CSF space.

In Japan, the Cerebrospinal Fluid Hypovolemia Research Group (directed by Kayama), beneficiary of a scientific research grant from the Ministry of Health, Labor, and Welfare, published their guideline “Diagnostic imaging criteria for cerebrospinal fluid leakage.” The guideline concerns not only CSF hypovolemia but also intracranial hypotension and CSF leakage, because no clinical diagnostic modalities which evaluate the amount of CSF volume were available. In this guideline, diffuse enhancement of the intracranial dura, subdural effusion, and ectatic venous sinuses are postulated as suggestive of intracranial hypotension. Epidural CSF collection on spinal MRI, abnormal extradural RI accumulation, circulation of RI, and early bladder filling in RI cisternography are all indirect findings suggestive of CSF leakage.

Certain problems sometimes make it difficult to evaluate CSF leakage adequately in RI cisternography. The problems include technical failure and individual variation in the circulation and absorption of CSF. Epidural leakage of RI, sometimes occurring during lumbar puncture, accelerates bladder filling of RI on account of hematogenous transfer via the epidural space. There is normal variation in terms of the bladder filling time of RI and RI clearance from the CSF space. Moreover, it is not rare that the CSF leakage point cannot be detected by numerous modalities including MRI, CT/MR-myelography, or RI cisternography. Spinal MR imaging or RI
cisternography also may not detect the leakage point in some cases. 2,3 Mokri’s study with CT cisternography identified the spinal level of a CSF leak in 67% of patients compared to 50% and 55% with spinal MR imaging and RI cisternography, respectively. 5

In our EBP procedure, we performed a lumbar puncture at the L3/4 level. A fluoroscopic view, showing only epidural distribution of the injected contrast medium, suggested the appropriate depth of the needle for EBP. About 30 ml of the patient’s own blood, collected via the brachial vein, was mixed with a contrast medium and slowly injected epidurally. Interestingly, a 3D-CT scan conducted just after the EBP showed that the contrast medium injected in the spinal epidural space vanished around the seventh cervical spine level. The contrast medium was clearly detected in the intradural space from around the seventh cervical spine level and extended to the cisterna magna. Absence of the contrast medium in the spinal intradural space at the thoracic and lumbar spine level suggested that the intradural migration of the contrast medium described above is not due to technical error, but due to the fistulization of the dura at the lower cervical spine level.

In the RI cisternography performed before EBP, the CSF leakage point was not specified. Moreover, the RI injected intradurally between the third and the fourth lumbar spine levels did not extend beyond the level of the conus medullaris. We speculated that rostral extension of the RI, injected at the level of the cauda equina, was blocked by the collapse of the CSF space due to large amount of CSF leakage, and also due to the compression of intradural CSF space by epidural CSF around conus medullaris level.

EBP is often performed in many spontaneous intracranial hypotension cases. The real mechanism of an EBP has still not been identified, but temporary increase in epidural pressure, reversing the CSF-blood gradient within the epidural space along the entire cord, sealing of the tear by coagulation of injected blood, and inflammatory reaction have been suggested as actions that promote the healing process of the dural tear. 4 In the patient reported here, own-blood injection into the epidural space via the lumbar spine level successfully improved the symptoms on the basis of the CSF leakage around the lower cervical spine level. It is unlikely that the own-blood injection closed the fistula by means of the patch effect because the fistula point was far from the injection site of the EBP and not so many of blood extended cervical spine level. Angelo emphasized that dural leaks are not the cause of the disease, but rather the effect of epidural hypotension maintained by the inferior cava vein outflow to the heart in patients with spontaneous intracranial hypotension. 2

We, therefore, suggest that the goal of the EBP procedure is not to seal CSF leaks, but instead to help in reversing the CSF-blood gradient within the epidural space along the entire cord. The correction of the CSF-blood pressure gradient by EBP may have facilitated the closure of the CSF leakage in our patient.

In conclusion, 3D-CT epidurography may be a useful tool to detect the fistula of a CSF leakage even in patients where other modalities including MRI, CT, or RI cisternography cannot specify the leakage point.

This was the first case for us in which 3D-CT epidurography detect the fistula of CSF leakage point, further use of this technique may clear useful of 3D-CT epidurography.

Conflicts of Interest Disclosure
The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices in the article. All authors who are members of The Japan Neurosurgical Society (JNS) have registered online Self-reported COI Disclosure Statement Forms through the website for JNS members.

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