Detection of CSF leaks with magnetic resonance imaging in intracranial hypotension syndrome

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KEY WORDS
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Summary Intracranial hypotension syndrome (IHS) is a rare disorder characterized by postural headache, low cerebrospinal fluid (CSF) pressure, dural thickening and pachymeningeal contrast enhancement as a consequence of decreased CSF volume. The present report is a case of spontaneous IHS due to dural leak at the level of T12—L1. The site of CSF leakage was not detectable on either conventional spinal MRI or T2-weighted MR myelography. However, it was evident on contrast-enhanced MR myelography (CE-MRM). The present report discusses the efficacy of CE-MRM in the detection of CSF leaks according to the literature so far.

Introduction

Intracranial hypotension syndrome (IHS) is an unusual disorder characterized by postural headache and low cerebrospinal fluid (CSF) pressure [1]. One of its main criteria is the demonstration of CSF leaks [2,3], and determining the exact location of CSF leakage is essential for increasing the efficacy of treatment [4]. In clinical practice, computed tomography myelography (CTM), radionuclide cisternography (RCC) and heavy T2-weighted (T2W) non-contrast-enhanced magnetic resonance myelography (NCE-MRM) are the most frequently used modalities for localizing CSF leaks [4—6]. Their efficiency, however, remains controversial, and they also have both limitations and disadvantages.

The present report is of a patient with spontaneous IHS and a dural leak located at the level of T12—L1. The CSF leak site was not demonstrable on conventional spinal MR and NCE-MRM images; however, the precise site was revealed by contrast-enhanced MR myelography (CE-MRM). For this reason, the aim of this report is to assess the efficacy of CE-
MRM in the detection of CSF leaks according to the literature so far.

Case report

A 42-year-old man presenting with IHS underwent intravenous (IV) contrast-enhanced (CE) brain MR imaging (MRI), which was normal except for a thickened, contrast-enhanced dura. One day after the brain MRI, NCE-MRM and precontrast CE-MRM were performed, following a protocol similar to that of previously published reports [1,3,5,6]. In addition, sagittal non-enhanced 3D fast low-angle shots (3D-FLASH) were used (TR/TE: 22/10; slice thickness: 1 mm) with a fast spin-echo (FSE) sequence for complete evaluation of the spinal canal. Acquisition time for both the NCE-MRM and precontrast CE-MRM was approximately 20 min. All MRI examinations were performed with a 1.5-Tesla MRI scanner (Magnetom Vision Plus, Siemens, Erlangen, Germany).

NCE-MRI failed to reveal the CSF leak or any other abnormal finding (Fig. 1). However, 3 h after NCE-MRM, CE-MRM was able to demonstrate CSF leakage. For the latter procedure, 0.5 mL of gadopentetate dimeglumine (Gd-DTPA, Magnevist; Schering, Berlin, Germany) was injected intrathecally, using a 26-gauge Chiba needle, into the lower lumbar region (L4–L5) under sterile conditions. Three-plane T1WSE and sagittal 3D-FLASH sequences (using the same parameters as for the precontrast images) were acquired 1 h after intrathecal Gd-DTPA administration. The patient was clinically observed for 48 h following the procedure, although no side effects or complications occurred.

CE-MRM showed CSF leakage at the T12–L1 level (Fig. 2). During the patient’s stay in hospital, autologous epidural blood patch (AEBP) was planned, but was postponed due to relief of his headache by conventional means. The patient was subsequently discharged with the recommendation to consult our clinic in case of recurrence.

Discussion

Diagnosing the etiology of IHS is of major importance [2,3]. The most common CSF leak location is at thoracic level. In the present case, the leak was at the T12–L1 level. The first step of IHS treatment is conservative. Surgery and AEBP, which is less invasive and cheaper than surgery, are also possible options [1,3]. However, as our patient responded to conservative treatment, there was no need to perform an AEBP.

Once the diagnosis of IHS is established, it is necessary to focus on the spine to find the exact location of CSF leakage [3]. The relevant studies include spinal MRI, CTM, RCC, NCE-MRM and CE-MRM [1–6]. RCC has long been used to locate CSF leakages in intracranial hypotension [4], and has a false-negative rate of 30% [7]. The major flaws of RCC are radiation exposure and failure to show minor leaks due to inadequate soft-tissue contrast resolution [2,4]. Although CTM is effective in locating leakage sites, it involves viewing numerous thin sections from the skull base down to the sacrum, resulting in inevitably high doses of radiation exposure [3,7]. Also, the viscosity of the contrast medium used for CTM is greater than that of Gd-DTPA and, thus, requires delivery with a thicker needle [8,9]. In such cases, the needle track itself may lead to false-positive readings with CTM.

NCE-MRM is a relatively new imaging technique that uses heavy T2W and produces high signal intensities from CSF [6]. NCE-MRM is frequently used to diagnose lumbar disc herniation and to investigate root compression [10]; unlike RCC, CTM and CE-MRM, it is non-invasive [1–6]. In addition, NCE-MRM offers a global view of the entire spine [6], and can provide additional data (such as effusions and meningeal diverticula) that are highly suspicious of a diagnosis of CSF leak. The technique, however, is not successful...
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in showing minimally active CSF leaks and cannot demonstrate physiological CSF flow [1,3]. Therefore, it may lead to false-negative results [6].

CE-MRM is also a new technique that is enjoying ever-increasing popularity [3,5]. The advantages of CE-MRM are the absence of radiation exposure, high soft-tissue resolution and the ability to provide multiplanar images [3]. Furthermore, CE-MRM is less invasive than CTM [8,9]. Although intrathecal low-dose (0.5-mL) gadolinium administration is not a widely recognized technique, it has been proven reliable in recent studies [3,8,9]. Moreover, CE-MRM can demonstrate, with great accuracy, CSF leaks that are not visible on spinal MRI, CTM or NCE-MRM [3].

In our present patient, routine spinal MRI and NCE-MRM failed to reveal the CSF leak that was demonstrated by CE-MRM at the level of T12—L1. In fact, the reported sensitivity of CE-MRM in IHS is around 89% [3]. Although there have been no comparative studies so far, this rate is nevertheless better than those of CTM (67%), RCC (55%), NCE-MRM (86%) and spinal MRI (50%) [1,3,6].

**Conclusion**

If no CSF leak is detected by NCE-NRM, then CE-MRM should be performed as a complementary procedure to enhance the delineation of dural integrity. Such a protocol appears to be the most reasonable approach, as it comes with no radiation exposure and is also less invasive than other investigations. However, further comprehensive studies in large series of patients are required to clarify any conclusions.

**References**