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Case Report

MRI myelography for diagnosis and targeted blood patching of multilevel thoracic spine CSF leaks: Report of 2 cases

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ABSTRACT

In patients with occult cerebrospinal fluid (CSF) leaks or CSF leak syndrome, orthostatic headaches are a common presenting symptom. Although computed tomography (CT) myelography has historically been the gold standard for diagnosis with radioisotope cisternography as a diagnostic alternative, magnetic resonance imaging (MRI) myelography using intrathecal gadolinium has reported sensitivity of 80%-87%. Two patients with spontaneous orthostatic headaches lasting for several days were diagnosed with CSF leaks at multiple thoracic segments using MRI myelogram with intrathecal gadolinium (Gadavist, Bayer, Whippany, NJ). This allowed for subsequent targeted treatment with CT fluoroscopy guidance, resulting in therapeutic responses within 1-2 treatment with targeted blood patching. Although intrathecal gadolinium is an off-label use, the superior contrast resolution and lack of radiation exposure makes MRI myelography an excellent imaging modality for diagnosing CSF leak, targeting treatment, and monitoring outcomes compared to CT myelography and radioisotope cisternography.

Introduction

In patients with occult cerebrospinal fluid (CSF) leaks, orthostatic headaches are a common presenting symptom. Spontaneous CSF leaks are most often multilevel and occur in the cervicothoracic junction or thoracic spine [1]. The MRI myelogram is an underutilized diagnostic tool in evaluating these patients [2]. Similarly, for a subset of patients within this cohort, particularly those with meningeal diverticula, prior

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neurologic trauma, or skull base leak, magnetic resonance (MR) myelography can be an integral tool for diagnosis [3–5]. Historically, the computed tomography (CT) myelogram or radioisotope cisternography has been the imaging modality of choice. This is compounded by the fact that intrathecal gadolinium administration is an off-label use for imaging purposes; thus making MRI myelography an under-utilized technique. Notably, studies have documented no complications with intrathecal gadolinium imaging, even with 12 months of follow-up in 1 study [4,6].

Small retrospective series demonstrated that MRI brain with IV contrast alone is on par with CT myelogram [7]. Interestingly, extravasation of dye on CT myelogram has been observed to not directly indicate the site of CSF leak, as assessed during surgery [8]. Another small retrospective series demonstrated that MR myelography (sensitivity 80%-87%) is on par with radioisotope cisternography (sensitivity 93%) for diagnosing CSF leak (kappa = 0.444-0.634) [9]. Furthermore, multiple small retrospective and prospective studies suggest that the increased neural soft tissue contrast provided by MR myelography can provide superior detection, localization, and post-blood patch evaluation of these leaks, making it a superior diagnostic and monitoring tool [5,6,10,11]. We present 2 cases of headache sufferers for which the MR myelogram diagnosed CSF leakages at multiple thoracic sites.

Case report 1

A 38-year-old male with no significant past medical history or trauma presented with 2-3 months of intractable orthostatic headaches. Symptom onset occurred spontaneously when he was walking his dog. Initial work-up including serology, CSF analysis, and nonenhanced CT brain were unremarkable. MRI with IV contrast demonstrated bilateral prominent subdural effusions, pachymeningeal enhancement, and a thoracic epidural fluid collection; all findings concerning for intracranial hypotension (Fig. 1A a-d). He was referred to neurointerventional radiology. Given the high suspicion of CSF leak, the decision was made to obtain an MRI myelography over a CT myelogram or radioisotope cisternogram, because of MRI superior contrast resolution of spinal soft tissue, intrathecal contrast, and the surrounding osseous spine.

After obtaining informed consent, MRI myelogram with 0.5 mL diluted intrathecal gadolinium (Gadavist, Bayer, Whippany, NJ) was performed to diagnose and localize the CSF leakage. Discrete CSF leaks from the T4-T8 bilateral neural foramina were identified in this patient (Fig. 1B e and f).

Exact localization allowed for targeted treatment using CT-guided blood patching via transforaminal and translaminal approaches targeted at the sites of the detected leaks (Fig 1C g-i). A 22 G spinal needle was used to administer the treatment, using a standard method. Prior to blood patching, 1-2 mL of contrast Isovue 200 was injected to confirm needle positioning. Approximately 2-3 mL of fresh autologous blood was then injected into each of the right T4-T5, left T5-T6, right T6-T7, and left T7-T8 transforaminal epidural space as well as the T5-T6 translaminar epidural space. This resulted in a total of 10-15 mL of blood patching within the thoracic spine.

With postprocedural resolution of symptoms, he was discharged. He did not return for a scheduled follow-up appointment. On a follow-up phone call, he stated his headaches fully resolved after 1 course of blood patching.

Case report 2

Similarly, a 45-year-old female presented with 4 days of new onset orthostatic headaches, different from her history of migraines. Her initial lab and imaging work including the brain were also normal, except for her MRI with IV contrast that only showed thoracic epidural fluid (Fig. 2A a-d). She had received a lumbar blood patch without symptom improvement. She was then referred to neurointerventional radiology. Her MRI myelography revealed discrete CSF leaks from the T5-T7 bilateral neural foramina were identified (Fig. 2B e).

As previously described, exact localization allowed for targeted treatment using CT-guided blood patching via transforaminal and translaminal approaches targeted at the sites of the detected leaks. Following a similar protocol as described above, a total of 10-15 mL of autologous blood patching was injected into the bilateral T5-T6 and T6-7 transforaminal as well as the midline T6-T7 translaminar epidural space.

She experienced transient relief of symptoms and was readmitted to the hospital 2 days after discharged. She received another 15 mL blood patch targeted at the T6-T7 translaminar epidural space. After the second targeted blood patch therapy, her symptoms resolved and follow-up MRI imaging demonstrated resolution of CSF leakage (Fig. 2C f-h).

Discussion

When there is high suspicion but no confirmatory evidence of spontaneous intracranial hypotension on initial work up, MR myelogram can be a sensitive diagnostic tool to detect and localize CSF leaks. The contrast resolution of gadolinium adjacent to soft tissue and bone in MRI myelogram provides excellent detection and localization for targeted blood patching of multilevel CSF leaks. Although intrathecal gadolinium is an off-label use, the superior contrast resolution of MRI myelography makes it a better tool for diagnosing, treatment targeting, and monitoring CSF leaks compared to CT myelography and radioisotope cisternography [5,6,10,11]. Both cases presented had a clinical diagnosis suspicious for CSF leak, and MRI myelography was able to identify the exact spinal levels of leakage, helping to confirm diagnosis and target therapy.

In 1998, Vakharia et al published a study about 5 patients who had received 20 mL of conventional blood patching of the lumbar spine for CSF leak after lumbar puncture with MRI as the modality for diagnosis, observing the tamponade effect, and monitoring the extent of blood patching spread. All 5 patients experienced immediate headache resolution. On MRI, there was anterior displacement of the thecal sac, suggesting that the tamponade effect is the therapeutic mechanism [12]. In our cases, the MRI myelogram localized 4 and 2 thoracic segments of leak in each patient for targeted therapy.

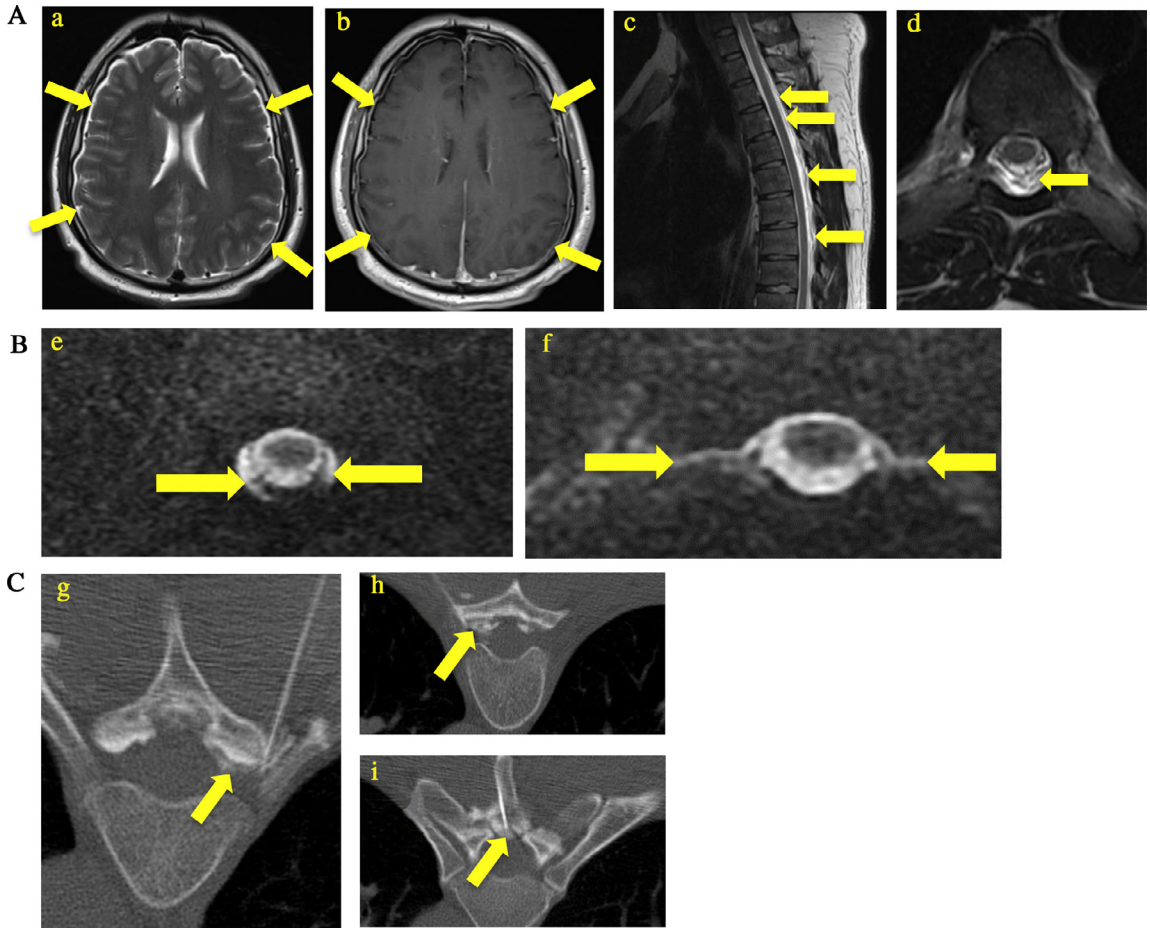

Fig. 1 – A. Indirect signs of intracranial hypotension on MRI.
(a) T2W brain MRI showing bilateral prominent subdural effusion. (b) T1W brain MRI with IV contrast showing pachymeningeal enhancement. (c) T2W sagittal thoracic MRI showing extradural fluid collections tracking posteriorly. (d) T2W axial thoracic MRI showing extradural fluid collection along the posterior thecal sac.
B. MR myelogram with intrathecal gadolinium.
(e) Axial views show CSF leaking into the posterior spinal epidural space at T4-T8. (f) CSF tracking and exiting the bilateral neural foramina.
C. CT fluoroscopy-guided needle placement for blood patching.
(g and h) Transforaminal and (i) translaminal approach at multiple thoracic levels. Preblood patch contrast injection demonstrates the distribution of contrast in the epidural space.

The first patient was directly referred to neurointerventional radiology when a CSF leak was suspected and had symptom resolution after 1 treatment with 10-15 mL of targeted blood patching. In contrast, the second patient was referred when she did not responding to a lumbar patch and symptom resolution required 2 episodes of targeted blood patching for a total injected blood volume of 25-30 mL. These cases illustrate that apart from having a clinical suspicion of CSF leak, patient history of post lumbar puncture vs spontaneous onset of orthostatic headaches should guide imaging work up and subsequently determining the location(s) of blood patch injection. Since most spontaneous CSF leak occur in the cervicothoracic spine, targeted blood patching has the greatest direct tamponade effect at the level of the spinal leak(s). Perhaps leaks across a smaller number of segments require larger blood patch volumes, because a greater amount of CSF must leak through a smaller number of openings, which means either a higher flow through each opening or a larger opening is present, requiring more pressure or blood volume to create adequate tamponade.

The standard volume used in lumbar blood patching is approximately 20-25 mL to achieve a tamponade effect [13,14]. Studies have also described using MRI to diagnosis and monitoring smaller volume 3-18 mL direct blood patching of cervical and/or thoracic leak sites [15–17]. Wu et al found that first epidural blood patch response rates were higher for anterior epidural fluid collections of <8 segments, targeted blood patching, and injected blood volume ≥ 22.5 mL [18]. Although the total volume of targeted blood patch for the second patient is slightly greater than the standard lumbar blood patch, each individual blood patch procedure used a lower blood volume. This is an important consideration for patients with multilevel thoracic and/or cervical leaks where there is a smaller spinal canal caliber and potential risk of compressing the spinal cord.

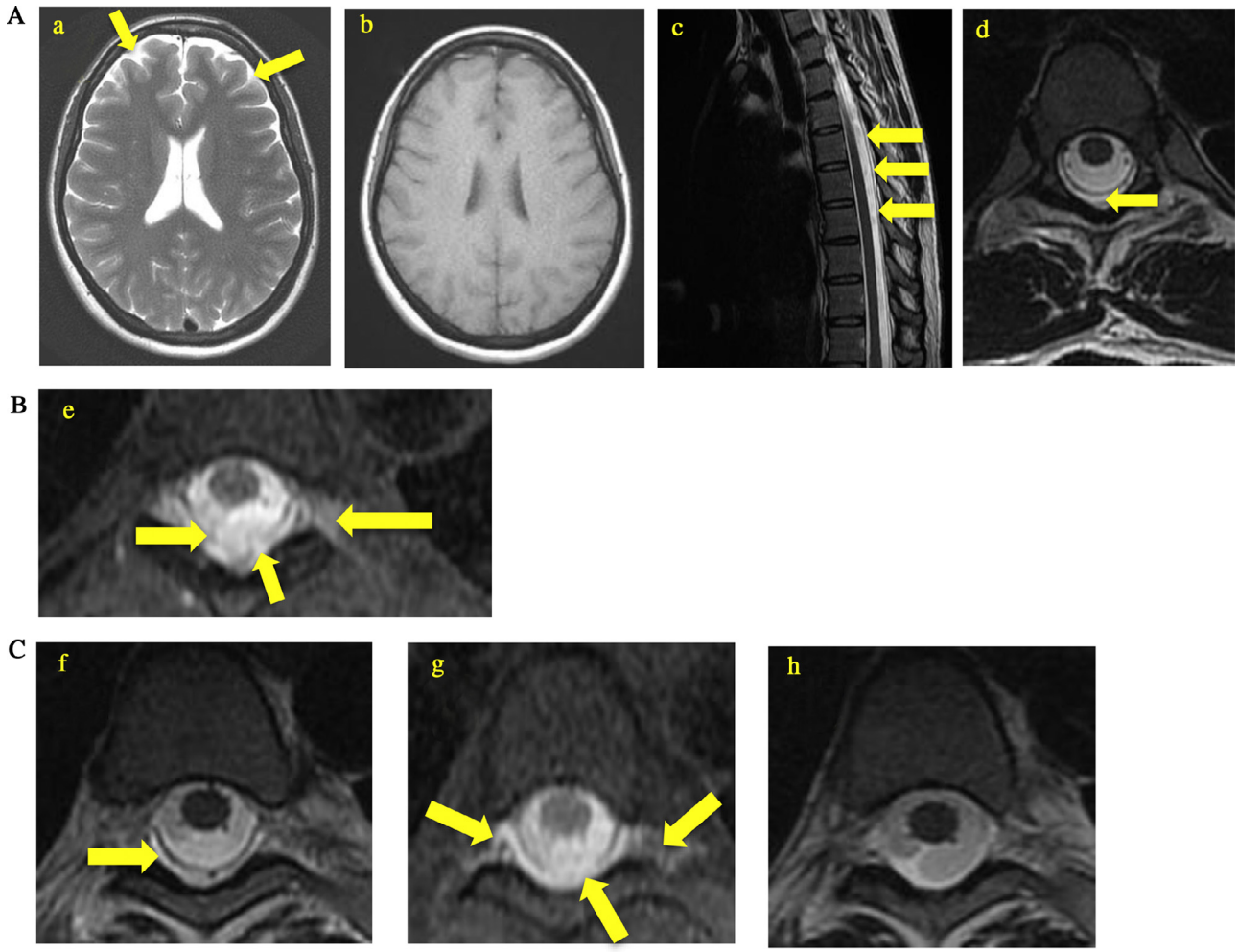

Fig. 2 – A. Indirect signs of intracranial hypotension on MRI.
(a) T2W brain MRI shows a possible trace subdural effusion in the frontal lobes. (b) T1W brain MRI with IV contrast demonstrates normal lack of pachymeningeal enhancement. (c) T2W sagittal thoracic MRI showing extradural fluid collections tracking posteriorly. (d) T2W axial thoracic MRI showing extradural fluid collection along the posterior thecal sac.
B. MR myelogram with intrathecal gadolinium.
(e) Axial view shows irregularity of the dural covering with CSF leaking into the posterior spinal epidural space and exiting the left neural foramen.
C. Resolution of CSF leak after targeted blood patching.
(f) T2 FRFSE axial image shows fluid in the posterior epidural space. (g) T1 with intrathecal gadolinium contrast showing a break in the posterior dura and CSF tracking along the posterior epidural space and exiting the bilateral foramina. (h) T2 FRFSE after blood patching showing absence of epidural fluid, the resolution of CSF leak.

Additional studies assessing and comparing imaging diagnosis, number of segmental leaks, tamponade symptoms during the procedure, such as radicular pain, and therapeutic volume of blood patching may contribute to improving the efficacy of a first blood patching treatment.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.radcr.2019.05.006.

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