Dynamic CT Myelography: A Technique for Localizing High-Flow Spinal Cerebrospinal Fluid Leaks

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Summary: In some patients with spontaneous spinal CSF leaks, leaks are numerous or tears are so large that extrathecal myelographic contrast material is seen at multiple levels during CT, making identification of their source impossible. This study introduces a dynamic CT myelographic technique that provides high temporal and spatial resolution. In this technical note, we describe the utility of this technique in four patients with challenging high-flow spinal CSF leaks.

Although many patients with spontaneous intracranial hypotension (SIH) recover without intervention or display a self-limited course, many do not (1). Some of these patients do not respond to multiple epidural blood patches and may require more targeted epidural injections, infusions, or surgical repair. In these patients, localization of the actual site or sites of CSF leak becomes important. In most patients, the site of leak can be localized by using conventional myelography with delayed CT imaging for slower leaks. When there are multiple leaks or large dural tears, the time delay during transfer between the myelographic portion of the examination and CT allows the extrathecal contrast to diffuse over multiple spinal levels, thus limiting the ability to localize the leaks. We define these as “high-flow” leaks and find them to be particularly challenging.

Technique

After placing a 25-gauge spinal needle at the level of the second lumbar interspace, remote from the suspected location of CSF leak in each case, the patient was transferred into the left lateral decubitus position onto the gantry of a 16-channel CT scanner. Care was taken to position the patient carefully so that the hips were slightly higher than the shoulders, and the patient’s side was supported with foam pads to prevent any lateral flexion of the spine. The head was elevated with foam pads to prevent rapid flow of contrast material into the cranial vault.

The standard CT technique included five scan acquisitions obtained during and immediately after injection of 15 mL 180 mgI/mL nonionic contrast material diluted in 15 mL of preservative-free 0.9% saline. Helical scans obtained by using 0.6-second myelographic portion of the examination and CT allows the extrathecal contrast to diffuse over multiple spinal levels, thus limiting the ability to localize the leaks. We define these as “high-flow” leaks and find them to be particularly challenging.

The rate of CSF leak can vary tremendously and is difficult to predict. We have found little correlation between the rate of CSF leak and clinical symptoms, MR imaging, or CSF opening pressure (4). For this reason, when conservative therapy has been unsuccessful, we typically perform a routine CT myelogram to localize the leak. If the rate of leak is low, it is helpful to obtain additional delayed CT images as much as 4 hours after contrast material infusion. Recently, gadolinium-enhanced MR myelography and MR cisternography (MR imaging after intrathecal introduction of

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gadolinium) have been reported as methods to improve detection of subtle CSF leaks (5, 6).

A different challenge is faced when the rate of CSF leak is so fast that contrast material diffuses over multiple levels during transfer to CT. This is the challenge of “high-flow” leaks. Multidetector CT is uniquely poised to provide the combination of spatial and temporal resolution necessary to localize these high-flow leaks. With the 16-channel scanner used in this study, contiguous 1.25-mm sections of the cervical, thoracic, and lumbar spine can be obtained in one breath hold.

The volume data sets created by these multichannel CT scanners can be unwieldy. Previewing the image volume by using fused 5-mm section thickness allows judicious selection of smaller subsets of the image volumes for thin section reconstruction. Image analysis on a workstation capable of producing multiplanar reconstructions aids interpretation. We found the oblique axial plane most helpful in displaying the site of leakage.

The dynamic CT myelographic technique we describe requires CT imaging during the injection of diluted myelographic contrast material. Thus, the infusion of contrast material cannot be monitored under fluoroscopic control. Particular care must be taken in placement of the spinal needle and subsequent transfer onto the CT gantry to ensure subarachnoid location of the needle tip. The patient must be monitored for symptoms of epidural contrast material injection. In addition, to minimize the risk of seizure, care must be taken to position the patient in the lateral decubitus position properly so there is adequate cephalic flow of contrast into the cervical spinal canal without allowing rapid ascent into the cranial vault. One of the four patients in whom we performed this examination developed a brief seizure, lasting 30 seconds, immediately after contrast material instillation. With head elevation, the patient experienced spontaneous recovery and was able to complete the dynamic CT examination with successful localization of the leak. At a 3-week follow-up appointment, the patient had no further sequelae.

Conclusion
We do not advocate using this technique for all patients with spontaneous intracranial hypotension who have failed conservative therapy. The rate of leakage varies considerably, and conventional CT myelography reveals the location of leak adequately for treatment in most cases. The dynamic technique is more invasive, has a higher radiation dose, and is more time intensive. In our practice, we reserve the
dynamic technique for the subset of patients with high-flow spinal CSF leaks who have failed conventional myelography. We have now used this technique in four patients with high-flow leaks and have successfully localized the leaks in all patients, including one particularly challenging patient in whom there were four spatially distinct foci of leaks (Figs 1–3). We have found this technique to be valuable in the evaluation of high-flow spinal CSF leaks.

References


Fig 3. Axial dynamic CT myelogram at the level of the C7–T1 interspace in the left lateral decubitus (A), right lateral decubitus (B), supine (C), and prone (D) positions demonstrates accumulation of extra-arachnoid contrast material along the left C8 root sleeve (open arrow). The final prone images, which were obtained 30 minutes after injection of contrast material, demonstrate dilution of contrast material in the previously unopacified epidural fluid collection (black arrow). Additional leaks were located at the level of the right T6 root sleeve and along the ventral aspect of the junction of the right T9 root sleeve and thecal sac (not pictured).