Benefit of Tomography in the Scintigraphic Localization of Cerebrospinal Fluid Leak

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A CSF leak was demonstrated by tomography after planar acquisition failed to localize it. The rotatagram was more definitive than the reconstructed images in showing the leak. Tomography should be considered when the leak may be in an unusual location and the patient does not have rhinorrhea or otorrhea. Tomography allows a complete 360° survey to examine for the best angle for inspection of the leak, whereas the empirically oriented planar study can sample only limited projections, particularly if given time limitations for acquisition.


Various radionuclide techniques have been used to demonstrate cerebrospinal fluid (CSF) leaks (1–8). Procedures range from counting pledges that have been placed in the nasopharynx (5) to gamma camera imaging of radionuclide transit through CSF under artificially increased pressure (7). The intermittent nature of many leaks render them difficult to detect even with sensitive techniques such as well-counting of nasal or ear pledges. We present a case in which a significant CSF leak is not only detected but also localized using tomography combined with a dynamic display of rotating images.

MATERIALS AND METHODS

Technetium-99m-diethylaminoetriminepentaacetic acid (DTPA) (Medi-Physics, Paramus, NJ) was injected into lateral ventricular CSF directly via an Ommaya reservoir. Imaging was performed immediately after injection for 20 min with planar techniques using a GE 300 Starcam (GE Medical Systems, Milwaukee, WI) with a low-energy, high-resolution collimator. SPECT imaging was then performed at 30 min after injection with a GE 400 Starview tomographic camera with a low-energy, high-resolution collimator. The tomographic camera has a shaved head that allows for imaging at the level of the mandible.

CASE REPORT

A 42-yr-old female underwent a transpalatal, transcival approach to clipping of a basilar artery aneurysm which had caused subarachnoid hemorrhage. During the hospital course, which spanned several months, she developed fungal meningitis that was treated with intrathecal Amphotericin B via an Ommaya reservoir. Surveillance cultures of the CSF showed continued presence of nasopharyngeal flora. Brain CT scanning 6 wk later, showed persistent air pockets and therefore a CSF leak was suspected (Fig. 1). The patient did not have rhinorrhea or otorrhea. Because of the lack of nasal or ear discharge, a standard pledget study was not attempted.

The patient was injected with 100 μCi (3.7 MBq) 99mTc-DTPA into the Ommaya reservoir. Apyrogenicity and sterility were assured by aseptic technique and the use of a 0.22-micron filter. Technetium-99m-DTPA was used instead of the standard radiopharmaceutical for CSF imaging, 111In-DTPA, because it was to be deposited centrally into the patient’s lateral ventricle and the ensuing early images would accurately represent a ventricular CSF flow and leak study. Delayed imaging was deemed unnecessary because the leak, if present, was estimated to be very close to the ventricular outflow. The use of [99mTc] pertechnetate, the agent of choice for CSF shunt studies, would not have been ideal because of its rapidly diffusing nature. If a lumbar approach had been undertaken, 111In-DTPA would have been the agent of choice for delayed imaging.

By depositing this low dose of relatively non-diffusible 99mTc-DTPA in the very small space of the ventricular CSF, the radioactivity per unit volume yielded a good count rate which was sufficient for superior resolution imaging (compared to 111In, for example) via planar techniques and/or tomography with a low-energy collimator.

Migration of the radiopharmaceutical from the Ommaya into the ventricle and basilar cisterns was visualized with planar imaging in lateral and lateral oblique views but no leak was seen (Fig. 1). An abdominal image was obtained immediately after planar imaging of the head was completed and was suspicious for a leak because of abnormal abdominal uptake (Fig. 1). There was no visualization of the thyroid or salivary tissue on the initial imaging that contained these glands in the field of view. Therefore, the presence of free pertechnetate was unlikely. Nevertheless, despite the probable detection of a leak by the abdominal image (9), localization of the site of the leak was not achieved by these planar methods.

The patient was moved to a rotating SPECT camera and 64 images over 360° were obtained. Reconstructed images were displayed in coronal, sagittal and transaxial projections (Fig. 2). Finally, the 64 planar images were compressed to 16 images, smoothed and displayed in a rotating format as a cine loop.

The leak was best localized on the rotating images of the compressed and smoothed raw tomographic data (Fig. 3). The
planar images did not show the leak. The reconstructed images were less clear in the demonstration of the abnormality.

The patient was subsequently treated with a ventriculoperitoneal shunt to create low CSF pressure. Additionally, nuclear localization of the leak at the basilar cistern above the palate directed the attending physicians in installing a venous blood patch through the patient’s palate. The patient was discharged after CSF cultures no longer produced bacterial growth.

DISCUSSION

Tomography should be used when an active CSF leak is suspected but the patient has no evidence of rhinorrhea or otorrhea. Tomography allows for a more efficient and complete circumferential survey than planar imaging and is particularly useful for cases in which the location of the leak is unknown or unusual. Although careful examination of the reconstructed images demonstrated the leak, it was much more obvious in the images from the rotatogram. The reason for this observation is that multiple slices from the reconstructed images have to be examined to define the leak and the intensity of the leak is relatively low when compared to other regions of normal CSF activity. Without inspection of the rotatogram, the leak could have even been dismissed as an artifact of backprojection.

The sensitivities and spatial resolution of the two cameras used are not different enough to account for the lack of localization of the leak by planar methods. Indeed, the non-tomographic camera detected the abnormal abdominal activity which prompted the next step in the imaging process: tomography.

A major advantage of SPECT is that it allows clear visualization of overlapping activity which is not achieved by planar imaging. In this case, the abnormal activity does not appear to overlap with normal CSF activity in several planes and so is easily seen on the rotatogram images generated from tomographic acquisition.

In most cases of suspected CSF leak, the optimum view...
angle is not known prior to the commencement of the imaging, and may not be achieved by empirically oriented planar techniques without considerable length of time involved with trial and error of correct positioning. For rarely performed scans such as for CSF leak detection, both the physician and technologist may find it difficult to interpret what they see as the camera acquires the planar images. Operator error in positioning the camera about the patient's head could result in a false-negative study. The relatively operator-independent positioning of the rotating gamma camera virtually excludes the possibility of an incorrect acquisition angle. The dynamically displayed, tomographically acquired images can clearly and easily show the best angle of projection for localization of the leak.

Tomography affords a 360° sampling that improves the likelihood of detecting small but active leaks in unusual locations. In this case, the decision was made to obtain 64 views in order to optimize the number of angles sampled, while simultaneously trying to reduce the time the patient needed to remain still for acquisition. The leak was seen on the non-filtered rotatogram images, however, the results were too noisy to photograph adequately. Therefore, image manipulation with a nine-point smooth and summation was used to improve the signal-to-noise ratio for a superior display.

Because of the location of the leak, it probably would not have been detected by nasal pledgets, which were not placed in this instance because the patient had no rhinorrhea.

We find it valuable to inspect the rotatogram on SPECT studies not only for quality control measures, such as ascertaining patient motion, but also for possible yield of relevant diagnostic as well as critically important information, as was the case in this demonstration of a CSF leak.

REFERENCES