Localization of dural fistulas using metrizamide digital subtraction fluoroscopic cisternography

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Demonstration of the exact site of dural fistulas in cases of cerebrospinal fluid rhinorrhea is difficult. Previous reports have described the use of metrizamide cisternography combined with either hypocycloidal tomography or computerized tomography; however, direct, dynamic, real-time visualization of the fistula is difficult with instillation of a minimal dose of metrizamide using those methods. A digital video subtraction fluoroscopy system can visualize the actual site of the fistula directly and dynamically using only a small amount of metrizamide.

KEY WORDS • cerebrospinal fluid rhinorrhea • frontal skull base fracture • digital subtraction fluoroscopy • metrizamide cisternography

CEREBROSPINAL fluid (CSF) fistulas that drain into the nasopharynx and cause CSF rhinorrhea can be difficult to localize. The structures of the frontal skull base and the paranasal sinuses are complex, with the overshadowing margins of bones often obscuring the exact location of the fistula. However, knowledge of the exact fistula site is essential for successful operative repair. With real-time digital video subtraction fluoroscopy, it has proved possible to visualize clearly the actual dynamic flow of metrizamide instilled by suboccipital puncture in two patients.

This paper describes a new technique for precise localization of fistulas, using only small amounts of metrizamide.

Localization Technique

As prophylaxis against convulsions, 100 mg of phenobarbital is administered intramuscularly to the patient 30 minutes before the study. The patient is placed in a prone position on the digital subtraction angiography table with the head flexed anteriorly and gently held with a Velcro strap. The table is inclined with the head about 10° to 15° below the horizontal plane. A suboccipital puncture is then made using a No. 22 disposable spinal needle under conventional lateral fluoroscopic control.

After confirming a backflow of clear CSF into the needle, 4 ml of metrizamide (170 mg I/ml) is introduced into the cisterna magna through a small-caliber connecting tube under real-time digital video subtraction fluoroscopy. The actual dynamic flow of metrizamide can be observed continuously, and the exact site of the fistula is visualized. To obtain a detailed axial tomographic view, the patient is taken to the computerized tomography (CT) scanner room and semicoronal serial CT cuts 1.5 mm thick are made with the patient in a prone position.

Case Reports

Case 1

This 34-year-old right-handed man was healthy until he fell 7 m from a building under construction. He struck the right frontal area of his head and fractured his right foot. He regained consciousness after several minutes and was admitted to the orthopedic department of a local hospital. About a month later, he complained of profuse nasal discharge while sitting or standing and was referred to our neurosurgical faculty for detailed examination.

* Fluoroscopy system, Model DVI-2CV, manufactured by Philips Electronic Instruments, Inc., Mahwah, New Jersey.
Examination. He was alert and without signs of meningeal irritation. The cranial nerves and other neurological examinations were all normal except for right anosmia. He complained only of copious amounts of a clear fluid draining from his nose. The nasal discharge tested positive for glucose.

Plain skull x-ray films showed a curvilinear fracture line in the right frontal bone adjacent to the right frontal sinus. The sphenoid and posterior ethmoid sinuses were cloudy. A CT scan disclosed a right frontal basal fracture and soft tissue density in the posterior ethmoid and sphenoid sinuses, but the frontal sinus was clear (Fig. 1). Hypocycloidal tomography of the anterior cranial fossa revealed possible bone disruption of about 10 mm in the planum sphenoidale.

Metrizamide cisternography was performed using digital video subtraction fluoroscopy and CT scanning. The suboccipitally instilled metrizamide flowed along the posterior border of the clivus and ascended the dorsum sellae and diaphragm by its own gravity. The metrizamide also sank into the posterior ethmoid sinus through the bone defect in the planum sphenoidale (Fig. 2). A CT scan performed immediately after this study with the patient in the prone position revealed layered metrizamide in the posterior ethmoid sinus. A shell-like accumulation of metrizamide was noted beneath the bone defect (Fig. 3). By comparing this scan with the previous plain CT scan (Fig. 1), we deduced that the bone defect was the site of the fistula.

Operation. A frontotemporal craniotomy was performed and the region of the planum sphenoidale was inspected intradurally. A dural defect about 1.5 x 1.0 cm in size was found exactly at the expected position. Slightly contused brain prolapsed into the dural defect. After separating and partially severing the prolapsed brain, the dural margin was exposed and the depressed portion of the bone was freed. Muscle fragments soaked in Biobond adhesive were packed into the bone defect and the dural tear was repaired with a small Lyodura patch.

Postoperative Course. The patient's was uneventful and the copious CSF rhinorrhea stopped. A postopera-

![Fig. 1](image1.png)

**Fig. 1.** Case 1. Computerized tomography scans revealing a right frontal basal fracture (arrows) and soft tissue density in the posterior ethmoid and sphenoid sinuses (asterisks). The reconstructed sagittal view shows a possible bone defect (arrowhead) in the planum sphenoidale.

![Fig. 2](image2.png)

**Fig. 2.** Sequential real-time digital video subtraction cisternography images in Case 1. The suboccipitally injected metrizamide (which shows black) is seen to have ascended the clivus (c) and is overlying the diaphragm (d) due to gravity. The metrizamide is also seen to have leaked into the posterior ethmoid sinus (arrowheads).
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tive skull x-ray film showed air in the posterior ethmoid and sphenoid sinuses.

Case 2

This 56-year-old right-handed man was admitted to the hospital for treatment of CSF rhinorrhea. Fluid drainage had begun 24 years earlier after he had sustained severe frontal trauma in an automobile accident; at times, it stopped spontaneously but frequently recurred. The patient underwent four left frontal craniotomies with muscle fragments soaked in Biobond adhesive and femoral fascia patching applied to the traumatized bone defect in the left cribriform plate. In spite of these procedures, the CSF rhinorrhea persisted with several episodes of purulent meningitis. Nasal discharge began again 6 months prior to this admission.

Examination. Neurological examination disclosed left anosmia and a left lower lateral quadrant visual field defect. Polytomography raised the possibility of a small bone defect in the left cribriform plate. Radio-

nuclide cisternography with lumbar injection revealed no apparent CSF leakage. Metrizamide CT cisternography via the lumbar route showed a collection of fluid in the ethmoid sinus, but the exact site of leakage could not be identified. A small defect in the left planum sphenoidale was identified on the coronal plain CT scan.

The patient was then examined by real-time digital video subtraction fluoroscopy as described in Case 1. The lateral view showed dynamic movement of metrizamide leaking through the bone defect into the posterior ethmoid sinus (Fig. 4). Immediately after this procedure, high-resolution metrizamide CT cisternography was performed (Fig. 5). On the basis of these results, the most likely site for the fistula was thought to be the bone defect in the left planum sphenoidale.

Operation. A left frontal craniotomy was performed; through the frontal porencephalic cyst the medial frontal skull base was exposed from the left anterior clinoid process to the planum sphenoidale. On separating the dura mater from the frontal skull base, defects in the dura and bone were found at the left planum sphenoidale. The site of this fistula was thought to be the same as that revealed by digital video subtraction fluoroscopy. Muscle fragments were minced and soaked in Biobond adhesive, and then packed into the bone defect. The defect was covered with a bone fragment and a fascial graft.

Postoperative Course. The patient's CSF rhinorrhea ceased and he was discharged with no new neurological deficits.

Discussion

The most frequent cause of CSF rhinorrhea is trauma, and secondary purulent meningitis is said to occur in 15% to 25% of these cases if suitable surgical therapy is not undertaken. Correct diagnosis and localization of the site of leakage are of great importance. There are many methods for detecting and localizing fistulas. Plain skull films and polytomography are indispensable techniques. Pneumoencephalography, Pantopaque cisternography, and metrizamide cisternography are sometimes useful, and radionuclide cisternography via the lumbar or suboccipital route may help. However, with these methods, false-negative results are common and exact anatomical localization is difficult. In 1982, Mamo, et al., described a new radionuclide scanning method that consisted of surgical trephination of the frontal bone, and direct subarachnoid injection of a radionuclide through this hole. With this frontal injection method, they reported a remarkably high detection rate of 93% for 30 cases of CSF leakage that they examined during the period. However, their method is too invasive.

Recently, metrizamide CT cisternography has been used to detect the exact site of fistulas. This method, however, is static, and the CSF leak from the bone defect cannot be actually seen. The ideal method

Fig. 3. Metrizamide computerized tomography cisternography scans in Case 1. The metrizamide is seen layered in the posterior ethmoid sinus (asterisks).
FIG. 5. Metrizamide computerized tomography cisternography scans in Case 2. A collection of contrast material is seen in the left ethmoid sinus (asterisk).

would permit direct visualization of the site of the CSF leak with fluoroscopy; however, the leakage site often cannot be seen clearly with conventional fluoroscopy because of the complexity of the contour of the frontal nasal bone and the paranasal sinus wall. Moreover, the contrast achieved with metrizamide is limited and disrupted by the surrounding bones. The digital video subtraction system was tried as fluoroscopy for dynamically detecting the exact site of leakage. This is the first report of this technique.


For our studies, Philips DVI-2CV equipment was used and the continuous mode was chosen; this could yield 30 serial images per second as originally designed for coronary angiography. The examinations were performed with the patient in the prone position and the neck flexed in order to increase the amount of leakage by elevating the intracranial pressure. The CSF leakage in our Case 1 was constant, but in Case 2 it was intermittent. Generally speaking, detection of CSF rhinorrhea is easier during leakage than when there is no leakage. So, when the site of CSF rhinorrhea cannot be detected, it is proposed that the intracranial pressure be raised artificially (for example, by intrathecal injection of physiological saline and/or by a Valsalva maneuver). Because only the lateral images can be obtained, metrizamide CT cisternography is performed immediately after each examination; then, the exact site of the leakage can be visualized in detail. These two cases had a bone defect at almost the same site in the planum sphenoidale, and the technique could detect the exact location quite easily.

References

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Manuscript received June 11, 1987. Accepted in final form November 13, 1987. Address reprint requests to: Tatsuo Takahashi, M.D., Department of Neurosurgery, Nagoya University School of Medicine, 65 Tsuruma-cho, Showa-ku, Nagoya 466, Japan.