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Cerebrospinal Fluid Rhinorrhea: Evaluation with Metrizamide Cisternography

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Metrizamide computed tomographic cisternography was used to examine 27 patients (19 males and eight females, 14–59 years old) clinically suspected of having cerebrospinal fluid fistulae with rhinorrhea. Twenty-one fistulae were traumatic and six were spontaneous. Five to 6 ml of metrizamide (or Iopamidol, two cases) were injected by lumbar puncture at a concentration of 185–200 mg I/ml for direct coronal and axial computed tomographic sections of the skull base. Cerebrospinal fluid rhinorrhea was present at the time of examination in 12 of 27 cases. Results were evaluated according to three criteria: (1) metrizamide passage through the bony and dural defect; (2) demonstrable site of the fracture and/or bony defect; and (3) metrizamide visualized within a paranasal sinus, nasal cavity, or cotton pledget. The examination was considered positive when criterion 1 alone was present and when 2 and 3 were associated. In 15 of 27 cases, cisternography was positive, with the exact site of cerebrospinal fluid leakage demonstrated in 10 patients. In six cases, the results were not definitive; only one of the criteria (2 or 3) was fulfilled. In six cases, cisternography was normal. Seventeen patients underwent surgery. The site of cerebrospinal fistulae was ethmoidal in nine cases, frontoethmoidal in seven, sphenoidal in two, and sphenoethmoidal in one. The relative value of metrizamide computed tomographic cisternography compared with other diagnostic studies, polytomography, positive or negative contrast studies, and radionuclides, is discussed. Diagnostic pitfalls include artifacts and partial volume effect.

Accurate demonstration of cerebrospinal fluid (CSF) leaks, either traumatic or spontaneous, has always been a difficult problem for radiologists and neurosurgeons as the numerous procedures for the purpose, plain skull films, complex motion tomography, positive or negative contrast studies, and radionuclide cisternography, testify. Most frequently, CSF leaks occur with rhinorrhea. When neglected, such leaks are serious because of the risks of infectious complications, the worst being bacterial meningitis. Preoperative and even intraoperative localization of the exact site of the CSF leakage is often difficult due to the small size of the bony and dural defects, and to the numerous possible sites of the fistula: frontal, ethmoidal or sphenoidal sinuses, petrous bone.

The advent of computed tomography (CT) and the use of new water-soluble contrast media such as metrizamide [1] and Iopamidol [2] provide a new mode of investigation. Metrizamide computed tomographic cisternography (MCTC) was first used in 1977 by Drayer et al. [3] and by one of us [4] to demonstrate CSF rhinorrhea. Since then, isolated cases [5–10] or short series [11, 12] have been reported confirming the utility of this method. The purpose of this paper is to report our experience in 27 cases of CSF rhinorrhea investigated with MCTC and to stress the potential value of this method.

Materials and Methods

During a 40 month period, we performed MCTC in 27 patients who were being evaluated

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TABLE 1: **Clinical and Radiologic Findings in CSF Rhinorrhea**

Type of Injury, Rhinorrhea at MCTC/Case No.	Age (years), Gender	Clinical Findings	Skull Films and Tomograms	Radioisotope Cisternography	MCTC	Surgery
Trauma, active:						
1	57, M	L rhin 9 y after injury	L frontoethmoidal F	0	+, A, frontoethmoidal	+
14	28, M	L intermittent rhin 14 m after injury	L frontal sinus F	N	±, C, frontal?	+
15	20, M	R rhin 2 m after injury; meningitis	Clouded L ethmoid; frontal pneumatocele	0	+, B + C, ethmoidal	+
16	20, M	L rhin 3 days after injury	L maxillary sinus F; L sphenoidal sinus F?	0	+, A + C, frontoethmoidal	+
19	14, M	L rhin 8 days after injury	R frontoethmoidal F; L ethmoidal F	0	+, B + C, ethmoidal	+
20	27, F	Bil rhin 3 y after pituitary surgery	Destruction, sellar floor	0	+, A, sphenoidal	Refused
21	44, F	L rhin 8 m after radiotherapy for Cushing syndrome	Sphenoid sinus opacity, dehiscent sellar floor	0	+, A + C, sphenoidal	+
Trauma, dry:						
2	27, M	Bil rhin 5 months after injury; anosmia	L frontoethmoidal F; L parietooccipital F	N	–	0
3	50, M	Bil rhin 2 m after injury; meningitis	L frontoethmoidal F; clouded L ethmoid	0	+, A, frontoethmoidal	+
4	48, F	Bil intermittent rhin 4 y after injury	Double sellar floor; clouded R ethmoid; R frontoethmoidal F	0	–	0
5	40, M	L rhin 7 y after injury	Opacity, paranasal sinuses	N	±, B, sphenoethmoidal	0
6	18, M	L intermittent rhin 8 m after injury	Nasofrontoethmoidal F	0	+, A, frontoethmoidal	+
7	25, F	R intermittent rhin 13 y after injury; recurrent meningitis (three)	R ethmoidal F	0	+, A, frontoethmoidal	Refused
8	14, M	R and L intermittent rhin 6 m after injury	R frontoethmoidal F	0	+, A, frontoethmoidal	+
9	29, F	R rhin 9 days after injury	R frontoethmoidal F	0	±, B, ethmoidal	0
10	19, M	R intermittent rhin 40 days after injury	N	0	–	0
11	40, M	R intermittent rhin 13 y after injury; recurrent meningitis ++	L frontomalar disjunction; L ethmoidal F	0	±, B, frontoethmoidal	+
12	23, F	L rhin 2 y after injury; meningitis	N	0	–	0
13	24, M	R intermittent rhin 5 m after injury; recurrent meningitis (two)	Frontal sinus F; lamina cribosa F?	N	–	0
17	14, M	Bil rhin 21 days after injury	L frontal sinus F; opacity paranasal sinuses	0	±, B, frontoethmoidal	+
18	51, M	R rhin 8 days after injury	Lamina cribosa F?	0	–	0
Spontaneous, active:						
22	53, F	R rhin; recurrent meningitis	Sphenoidal sinus opacity	0	+, B + C, ethmoidal	+
23	48, F	R rhin	Empty sella; thinning sellar floor; fluid level sphenoidal sinus	+	±, C	+
24	55, M	R rhin 2 y after surgery for occipital meningioma; active hydrocephalus	Clouded R ethmoid	±	+, B + C, ethmoidal	+
25	14, M	Bil rhin after surgery for craniostenosis; recurrent meningitis (three)	Clouded ethmoid; anterior floor agenesis	0	+, B + C, ethmoidal	+
27	31, M	R rhin; craniostenosis; meningitis, seizures	Craniostenosis; empty sella; dehiscent lamina cribosa; nasal meningocele	0	+, A + C, ethmoidal	+
Spontaneous, dry:						
26	30, M	L rhin; recurrent meningitis (two)	Opacity, paranasal sinuses; dehiscent lamina cribosa?	0	+, A, frontoethmoidal	+

Note.—L = left, R = right, rhin = rhinorrhea, y = years, m = months, F = fracture, 0 = not performed, N = normal, + = positive, ± = not demonstrative, – = negative, bil = bilateral. Criteria A, B, and C are described in the legend of figure 1.

for clinically suspected CSF rhinorrhea in whom routine radiologic procedures were either normal, equivocal, or believed to offer insufficient information on which to base clinical management. There were 19 males and eight females 14-59 years old. They were classified according to Ommaya et al. [13] as traumatic or nontraumatic. The clinical presentation, along with the results of the various radiologic studies, are shown in table 1.

Twenty-one cases were *posttraumatic* (cases 1-21), 19 resulted from traffic accidents or closed head injuries and two were iatrogenic after transsphenoidal surgery for pituitary adenoma (case 20) and radiation therapy for an ACTH-secreting pituitary tumor (case 21). In posttraumatic cases, MCTC was performed for: (1) isolated CSF leaks lasting from a few days to 9 years (17 cases) or (2) intermittent rhinorrhea complicated by bacterial meningitis (two cases). At the time of examination, active rhinorrhea was present in seven patients, and it was intermittent or "dry" in 14.

Six cases were *nontraumatic* (cases 22-27): two craniostenoses (cases 25 and 27) had agenesis of the floor of the anterior fossa (one was associated with an empty sella); case 24 had active hydrocephalus secondary to an occipital meningioma operated on two years before; and case 23 had a primary empty sella. In cases 22 and 26, no predisposing factor was found. MCTC was performed 15 days to 2 years after the onset of rhinorrhea. Episodes of bacterial meningitis occurred in four patients; for one of these (case 25), recurrent meningitis prompted hospitalization. Active rhinorrhea was present in five of six patients at the time of examination.

All patients had plain films of the skull, hypocycloidal tomography of the skull base and paranasal sinuses in posteroanterior and lateral views, and six had radionuclide cisternography.

In the six cases of spontaneous rhinorrhea, a routine CT examination, including intravenous contrast medium injection, was performed in order to eliminate high or normal pressure hydrocephalus or tumor.

MCTC was performed according to the technique previously described [3-5]. Five to 6 ml of a nonionic water soluble contrast medium (metrizamide, Nyegaard, Oslo, Norway, and Winthrop, France, 25 cases; Iopamidol, Bracco, Milan, Italy, and Schering, France, two cases) at a concentration of 185-200 mg I/ml were injected by lumbar puncture under fluoroscopic control using a 20 G, 8.9 cm spinal needle. Cotton pledgets were placed into each nostril when active rhinorrhea was present at the time of examination (12 of 27 cases). When the rhinorrhea was slow or intermittent, the patient was asked to cough or to perform a Valsalva maneuver in order to increase the CSF leakage. The patient was tilted head down to −60° in prone position for 1-2 min and returned to −10° position. The patient was then transported in the same position on a stretcher to the CT scanner unit (Delta 25 Head Scanner). The patients were usually scanned in the position that induced the greatest CSF leakage. Direct coronal sections in prone position from the sphenoid sinus posteriorly to the frontal vault anteriorly, and axial transverse sections at −10°–−15° to the canthomeatal line in supine position were scanned using 5 mm collimation with overlapping. Sagittal reformations were not very helpful and were generated in only three patients.

All patients undergoing MCTC were premedicated with 10 mg of intramuscular Valium 30 min before the examination. In case 27, with a previous history of seizures, antiepileptic treatment also included phenobarbital 3 days before and after MCTC. MCTC scans were studied at different window and level settings to differentiate enhanced subarachnoid spaces, bone, paranasal sinuses, and nasal cavities. Bony defects and/or fractures of the base of the skull were compared on plain films, polytomography, and CT cisternographies. Only marked differences in absorption coefficients were regarded as significant to differentiate enhanced subarachnoid spaces from bone.

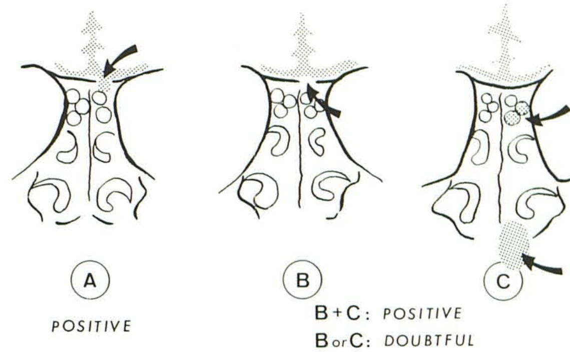
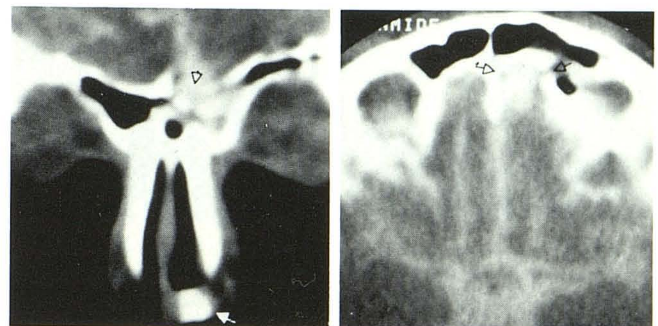


Fig. 1.—Criteria used to evaluate results of MCTC in CSF rhinorrhea. Metrizamide in stippled areas. **A**, Metrizamide passage through bony and dural defect. **B**, Site of fracture and/or bony defect. **C**, Metrizamide visualized within paranasal sinus, nasal cavity, or cotton pledget.



A **B**

Fig. 2.—Posttraumatic rhinorrhea, case 16. Direct coronal (**A**) and axial (**B**) MCTC sections. Passage of metrizamide into frontoethmoidal bony defect (**B**, *arrows*). Cotton pledget placed into left nostril is opacified (**A**, *arrow*).

Results

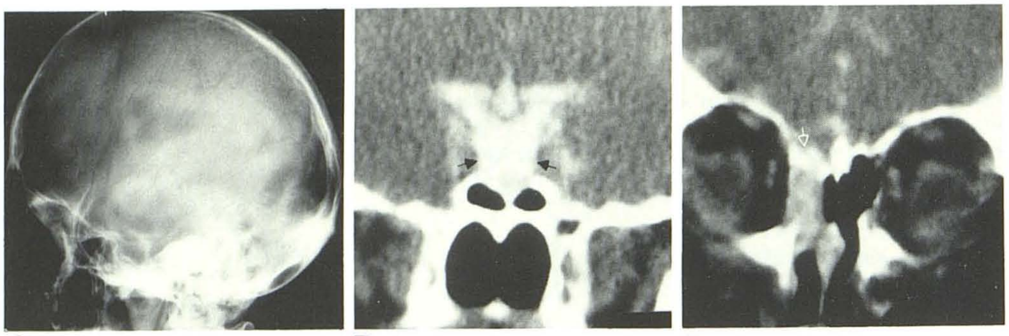
The results were evaluated according to three criteria (fig. 1): (1) direct demonstration of metrizamide passage through the bone and/or dural defect; (2) precise site of the fracture(s) and/or bony defect(s); and (3) visualization of metrizamide within paranasal sinus, nasal cavity, or cotton pledget. Examination was considered positive when criterion 1 alone was present or when 2 and 3 were associated.

In 15 of 27 cases, MCTC was positive (table 1). Of these, the exact site of the CSF leakage was demonstrated in 10 patients (figs. 2-4). Of the 15 patients, 13 had surgery (two patients refused operation), and surgery confirmed the localization of the fistula documented by MCTC in all cases. It is worth noting that five patients with no leakage at the time of examination had positive MCTC (cases 3, 6, 7, 8, and 26).

In six cases, the results were not definitive; only one criterion, 2 or 3, was fulfilled (fig. 5). However, surgery confirmed the suspected fistula in the four cases. Four of these six patients had dry rhinorrhea at the time of MCTC.

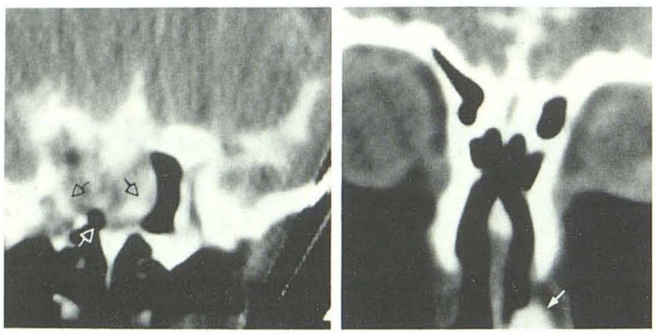
In six cases, MCTC was normal or negative and no surgery was performed. All had slow or intermittent rhinorrhea and did not leak during examination.

The site of the CSF fistula was demonstrated in 19 cases: nine were ethmoidal (mainly near the lamina cribosa), seven frontoethmoidal, two sphenoidal, and one sphenoethmoidal.



A B C

Fig. 3.—Spontaneous rhinorrhea with recurrent episodes of meningitis, case 27. **A**, Plain skull film. Craniostenosis. **B** and **C**, Direct coronal MCTC sections. Empty sella (**B**, *arrows*) and filling of right ethmoidal cells by metrizamide associated with bony breach of right lamina cribosa (**C**, *arrow*).



A B

Fig. 4.—Iatrogenic rhinorrhea following radiation therapy for Cushing syndrome, case 21. **A**, Direct coronal MCTC section. Destruction of sella floor (*white arrow*) with passage of metrizamide into sphenoid sinus (*black arrows*). **B**, Opacification of cotton by contrast (*arrow*).

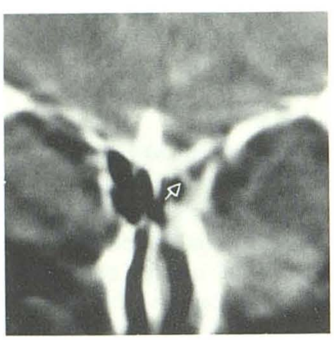


Fig. 5.—Posttraumatic rhinorrhea, case 17. Direct coronal MCTC section confirms left frontoethmoidal bony breach demonstrated on polytomography. Linear hyperdensity within left ethmoid (*arrow*) was not considered as Metrizamide passage and MCTC was interpreted as doubtful. Surgery confirmed bony and dural breach at this level.

Bony defects and fractures were demonstrated by plain skull films and polytomography in 18 of 27 cases, and by CT in 19.

However, correlation between polytomograms and bony defects as seen on CT showed some discrepancies between the two procedures. In case 11 (*right* intermittent posttraumatic rhinorrhea), complex motion tomography showed a frontomalar disjunction with a discontinuity of the lamina cribosa on the *left*; CT demonstrated a *right* paramedial breach of the lamina cribosa that was confirmed at surgery. In case 15 (*right* posttraumatic rhinorrhea), polytomography showed clouded ethmoidal cells on the *left* side with no abnormality of the lamina cribosa (fig. 6); CT revealed *bilateral* bony breach of the lamina cribosa that was confirmed surgically.

In case 16 (*left* posttraumatic rhinorrhea), a *left* sphenoidal sinus fracture was suspected on complex motion tomography, but CT clearly demonstrated the passage of dye in a *left* frontoethmoidal breach (fig. 2); this was confirmed at surgery. In case 19, tomography and CT were complementary; this patient had a *left* posttraumatic rhinorrhea, and complex motion tomography showed a *bilateral* frontoethmoidal fracture, MCTC demonstrated a *right* lamina cribosa fracture with passage of Iopamidol into the *right* ethmoid (fig. 7). Surgery confirmed the breach on the *right* lamina cribosa and a second small breach on the *left*.

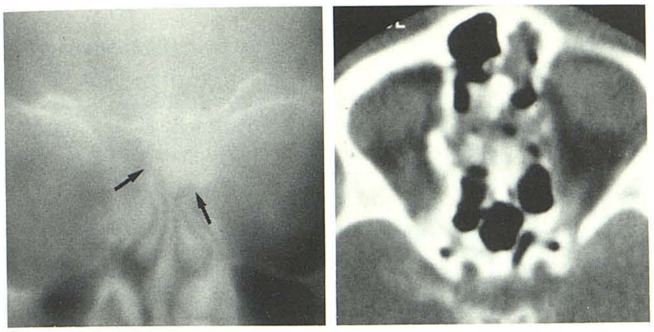
Radionuclide cisternography was performed in six patients: four were normal, one positive, and one not demonstrative. Comparison with MCTC (table 1) shows that radionuclide cisternography is less convincing than CT cisternography in precisely defining the site of the CSF leak.

Tolerance of MCTC was good. One-third of the patients (nine of 27) experienced mild headache and/or nausea 3–4 hr after intrathecal injection of metrizamide or Iopamidol that lasted 3–24 hr. No severe adverse reactions, such as seizures or perceptual alterations, were observed.

Discussion

The Ommaya classification of CSF rhinorrhea into traumatic (including surgery) and nontraumatic is important owing to the differences in clinical features and natural history [13]. Traumatic cases are definitely more common, representing 77% of 27 cases in our series and 67% of 51 cases in the Lantz et al. [14] series. Lewin [15] reviewed 100 unselected cases of head trauma and found a 7% incidence of basal skull fractures of which two cases had CSF leaks. According to Ommaya [16], traumatic cases most often have an abrupt onset within 48 hr after trauma and stop within 1 week in 70% of cases and usually within 6 months in the rest. Nontraumatic leaks have an insidious onset, are associated with greater flow, and may continue for years. Anosmia was reported in 78% of traumatic cases but is rare in nontraumatic cases. Ommaya reported meningitis in 25%–50% of untreated traumatic cases but less frequently in nontraumatic cases. In our series, meningitis was present in 10 (37%) of 27 cases.

Accurate localization of the site of CSF leakage is essential whenever surgical intervention is considered. Plain skull films, tomography, and radioisotope cisternography were the most commonly used techniques prior to the advent of CT [13, 17–19]. Lantz et al. [14] found plain skull films to be helpful in 21% of 51 cases and tomography in 53% of



A B

Fig. 6.—Right posttraumatic rhinorrhea, case 15. **A**, Frontal polytomogram. Left clouded ethmoidal cells (*arrows*) but no patent abnormality of lamina cribosa. **B**, Axial CT cisternogram with Iopamidol. Bilateral opacity in upper ethmoid cells.

cases (especially 10 of 13 traumatic noniatrogenic cases). Plain films and tomography showed a bony defect in 66% of all cases, and in 57% of operated cases in our series, whereas CT showed a defect in 70% of our total cases and 82% of operated cases. Dohrman et al. [7] found tomography more sensitive than CT, but used CT sections of 13 mm. When more than one bony defect is present, CT is superior to polytomography in showing which is responsible for the leak (cases 11, 15, 16, and 19).

Radionuclide cisternography was helpful in localizing the leakage site in 50% of the Lantz et al. cases and suggestive in 25%. Our use of radionuclide cisternography was limited to six cases, of which one was positive and one suggestive. Four of the six cases did not have active rhinorrhea. Metrizamide cisternography was positive in one case (case 24) and suggestive in three (cases 5, 14, and 23). MCTC is preferable to radionuclide studies because of its greater availability and easier handling, more precise definition of the leakage site and rapidity of study. Radionuclide studies may be misleading when the dripping nostril is opposite the actual side of leakage.

In addition to our previous report [4], we found 14 other cases of MCTC in CSF rhinorrhea in the literature [3, 6–12]. Eight of the 14 cases were posttraumatic. MCTC was positive in all 14 cases; radionuclide studies were positive in five of five cases, but never showed the exact site of CSF passage. The fistula site was cribiform in six cases, sphenoidal in four, and ethmoidal in four. Ghoshhajra [12] published the largest series, which included six cases and, like Naidich et al. [8], stressed the use of coughing and lateral decubitus views in difficult cases. This technique of lateral decubitus positioning was useful in case 19 (fig. 7).

Naidich and Moran [11] used saline infusion into the subarachnoid space to raise the intracranial pressure in slow flowing or intermittent leaks. This technique is contraindicated in patients with evidence of elevated pressure, mass lesions, or brain edema.

Of the 27 cases in our series, 15 did not have active flow at the time of MCTC. Although we did not use saline infusion to raise intracranial pressure, MCTC was positive in five patients and suggestive in four patients with dry rhinorrhea. The latter four cases were surgically confirmed. The presence of active flow is not absolutely necessary to diagnose a CSF fistula. The site of communication may be covered immediately or secondarily by a herniation of cerebral tissue forming a plug preventing CSF leakage but insufficient to prevent bacterial contamination.

In all six patients with negative MCTC, the rhinorrhea had been slow or intermittent and was not flowing at the time of study. Surgery was not performed in these patients. There were no false-positive cases in our series in which MCTC suggested a fistula site that could not be located at surgery.

Pitfalls in MCTC include partial volume averaging with osseous structures and presence of blood within the sinuses after trauma. Decubitus views in the former instances may be helpful in demonstrating a fluid level. Premetrizamide CT may be helpful in the latter instances when MCTC is to be performed within a few days after trauma.

The good patient tolerance of MCTC in our series agrees with the results of Drayer and Rosenbaum [6], in which 38% of patients had headaches, 38% had nausea and vomiting, and 8% had subtle perceptual alterations, all of which were limited to less than 24 hr.

MCTC is recommended for all cases in which surgical repair of CSF rhinorrhea is considered. Plain skull films and polytomography may be helpful in demonstrating fractures or bony defects. New computer programs for increased bony resolution may also prove to be useful in the future.

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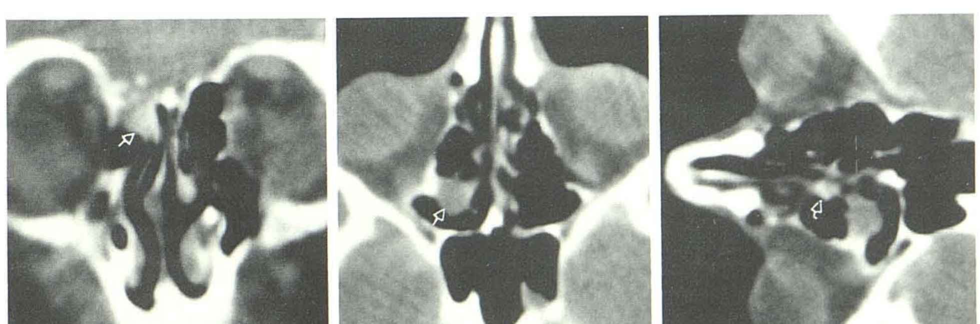

A B C

Fig. 7.—Left posttraumatic rhinorrhea, case 19. **A**, Direct coronal section. Right bony defect on lamina cribosa with opacification by Iopamidol of right ethmoidal cells (*arrow*). **B**, Axial section in brow-up position. Doubtful clouding in right ethmoidal cell (*arrow*). **C**, Section in right lateral decubitus position. Asymmetric opacification with layering of contrast medium in ethmoid (*arrow*).

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