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Small Acoustic Neuromas:
Detection by High Resolution Gas CT Cisternography

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Experience with 81 gas computed tomography (CT) cisternography procedures in 79 patients in searching for acoustic neuroma is reported. Twenty-one tumors, four exclusively intracanalicular, were demonstrated after standard contrast-enhanced CT was negative. Fifty-five examinations were negative; four were inconclusive. The high resolution scanner with digital localization and reconstruction zoom capability greatly improved image detail. In nine of the 12 normal patients examined with it, the intracanalicular bundle was demonstrated. Substitution of carbon dioxide for air greatly reduced the morbidity of acute post-spinal tap headache. The procedure takes 30–45 min and can be performed on an outpatient basis. It is recommended as the procedure of choice when standard CT is negative in subjects clinically suspected of having acoustic neuroma.

Since the initial reports on air computed tomography (CT) cisternography (CTC) [1, 2], three developments have prompted us to update the report of our experience. Availability of a high resolution scanner with software capability for reconstruction zoom imaging has greatly improved image detail [3, 4]. Introduction of filtered CO_2 (Acrodisc disposable 25 mm filter assembly, product #4192, Medical Device Division, Gelman Sciences, Inc., Ann Arbor, MI 48104) instead of air has dramatically decreased the acute headaches in our patients. The demonstration of four purely intracanalicular acoustic neuromas encourages our continued use of this technique. Our experience with 81 gas CTC procedures on two CT scanners is analyzed.

Materials and Methods

The scanners were the EMI 5005 and the GE CT/T 8800. The narrowest slice available with the EMI 5005 was 5 mm and with the GE CT/T 8800, 1.5 mm. Digital localization radiography and reconstruction zoom imaging were only available to us on the GE CT/T 8800. Eighty-one examinations were performed on 79 patients; 61 on the EMI 5005 and 20 on the GE CT/T 8800. All patients had previously had a contrast-enhanced CT study that failed to demonstrate a suspected cerebellopontine mass lesion. Forty-seven examinations were carried out with air and 34 with CO_2.

The technique described here is applicable to any scanner with localization radiography and slice capability of 3 mm or less. A 22 gauge lumbar spinal needle is inserted into the lumbar subarachnoid space with the patient sitting on the CT table. The gas is introduced with the patient tilted lateral 45° to the plane of the CT table and the head additionally tilted 45° with the side to be examined superior. A characteristic retroorbital, retroauricular, and/or temporal pain occurs when the gas reaches the cerebellopontine angle cistern. A total volume of 5–6 cm^3 of filtered CO_2 is introduced. The patient is then placed in the lateral decubitus position on the CT table with the side to be examined superior. (All CT

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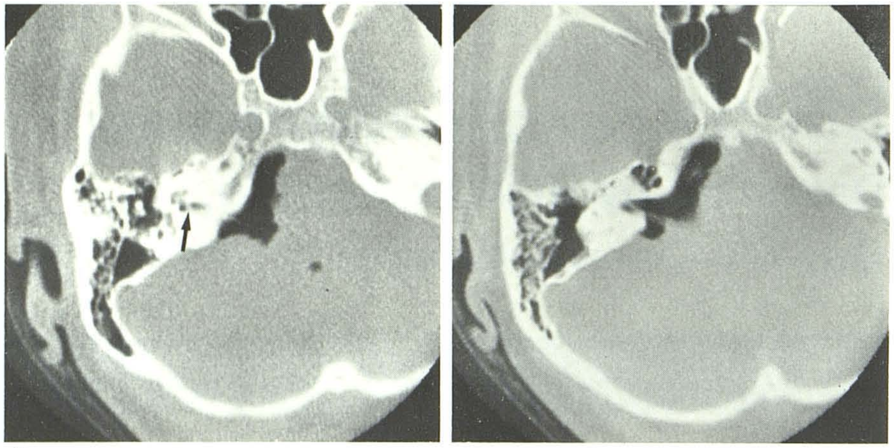

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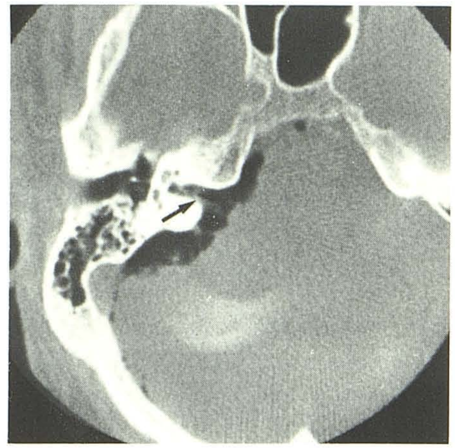

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Fig. 1.—Normal gas CT cisternography. **A**, Scan cut through inferior aspect of internal auditory canal. Gas in lateral part of canal and within right cerebellopontine angle cistern. Part of neurovascular bundle seen at most lateral aspect of gas in cistern before its entrance into porus acusticus. Linear structure, coursing through tractus spiralis foraminosus to modiolus of cochlea, represents cochlea division of eighth cranial nerve (*arrow*). **B**, Higher scan cut through midpart of right internal auditory canal. Gas fills entire canal. Neurovascular bundle courses through gas-filled cistern and within internal auditory canal.

Fig. 2.—Normal gas CT cisternography. Gas in right cerebellopontine angle cistern. Linear structure, coursing through cistern and entering gas-filled internal auditory canal, is neurovascular bundle. Second density with hairpin turn configuration in most proximal aspect of internal auditory canal represents petrous artery branch of anterior inferior cerebellar artery (*arrow*).

images illustrated in this report were obtained in the decubitus position but are displayed in the conventional manner for ease of orientation.)

Once the patient is in the lateral decubitus position, a frontal digitized radiograph is obtained. The internal auditory canal is localized by a cursor and a 5 mm scan is made to determine if an adequate amount of gas fills the cistern and/or canal. Once the internal auditory canal is demonstrated, six 1.5 mm scans are performed at 2 mm intervals through the canal, three slices on either side of the center of the 5 mm slice, and reconstruction zoom images (ReView) are subsequently obtained. Six slices usually suffice to evaluate the cistern and canal. The actual slice thickness is 1.8 mm (information obtained through General Electric) and thus only 0.2 mm is skipped between slices. This is not believed to be significant and we have seen no reason to alter our practice.

Two patients had bilateral procedures, on one side performed as outlined above. The spinal needle is left in place on completion of the initial study. The patient is then elevated to a sitting position and rotated 180°, tilted lateral 45°, and the head additionally tilted 45° with the opposite side now superior. An additional 5–6 cm^3 of filtered CO_2 is introduced, and the patient is placed in the lateral decubitus position for CT imaging.

Results

There were 55 normal studies and 21 studies that demonstrated an acoustic neuroma, four of which were purely intracanalicular. The cisternal segment of the neurovascular bundle was seen in 40 of the 55 normal cisterns. Reconstruction zoom images produced from GE CT/T 8800 scans demonstrated the intracanalicular part of the neurovascular bundle in 10 of 12 normal patients (figs. 1 and 2). At no time was the intracanalicular segment of the neurovascular bundle demonstrated on studies performed on the EMI 5005.

The hairpin turn of the anterior inferior cerebellar artery (petrous artery) within the internal auditory canal was demonstrated in one of the 12 normal cases (fig. 2). Nine normal patients were immediately rescanned on the GE CT/T 8800 after intravenous infusion of contrast medium, but there was no enhancement of any linear structures in the cerebellopontine angle cistern that could be identified as vessels.

Postprocedure symptoms were compared between the group who received air and those who received filtered CO_2. Twenty of 47 patients had a headache of varying degrees when air was the contrast medium. When CO_2 was used, three of the 34 patients had a headache 1 hr after the procedure was concluded.

The demonstration of a purely intracanalicular tumor by gas CTC has not been reported previously (fig. 3). The four tumors were entirely confined within the internal auditory canal and did not exit the porus acusticus. All four tumors prevented total filling of the internal auditory canal with gas. Three examined with the GE 8800 scanner had a convex border medially. This detail could not be seen in the tumor examined on the EMI 5005 scanner.

Our total of 81 CTC procedures demonstrated 21 acoustic neuromas of various dimensions (fig. 4). There were four inconclusive air studies, all of which were examined on the EMI 5005 scanner with its limitation of a 5 mm slice thickness. In one equivocal study, no gas or contrast medium reached the cerebellopontine angle cistern, having become trapped within a thoracic arachnoid "cyst." The patient refused a C1–C2 puncture for reexamination.

One lesion other than an acoustic neuroma was discovered (fig. 5): a 3 mm filling defect in the lateral aspect of the internal auditory canal. At translabyrinthine resection, the surgeon resected a mass lesion that histologically was composed of sensory ganglion cells with lymphocytic infiltration. This was believed to be an inflammation (ganglionitis) of the neurons of the sensory ganglion of the eighth cranial nerve. No false-positive diagnoses were made with the technique.

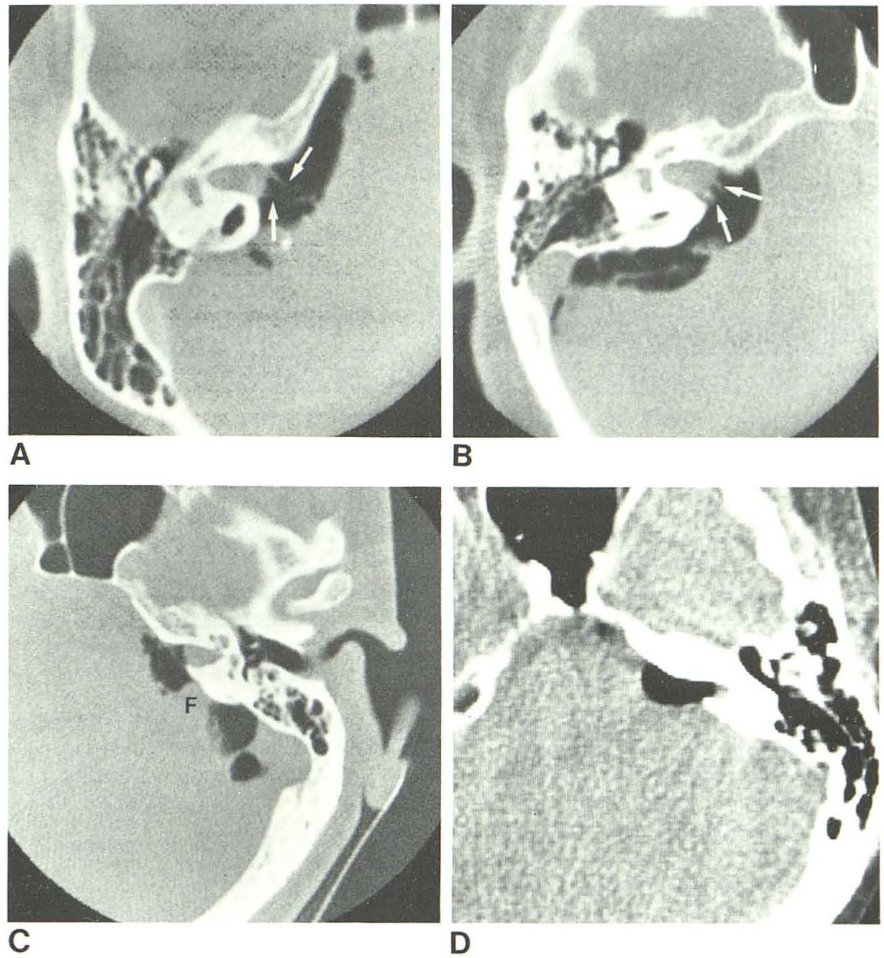

Fig. 3.—Intracanalicular acoustic neuromas. **A**, Intracanalicular acoustic neuroma with gas outlining soft-tissue lesion with convex border at porus acusticus. Neurovascular bundle at medial aspect of tumor (*arrows*). **B**, Another intracanalicular acoustic neuroma. Tumor prevents filling of right internal auditory canal by gas. Neurovascular bundle within gas-filled cerebellopontine angle cistern. **C**, Gas fills left cerebellopontine angle cistern at porus acusticus. Prominent flocculus (F) posterolaterally. Soft-tissue density with convex border to gas preventing filling of internal auditory canal is intracanalicular acoustic neuroma. **D**, Intracanalicular acoustic neuroma shown on EMI 5005. Lesion prevents complete filling of internal auditory canal by gas. Lesion produces concave border of gas. No neurovascular bundle demonstrated.

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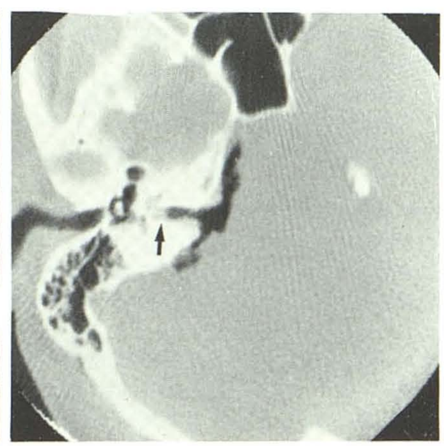

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Fig. 4.—Intra- and extracanalicular acoustic neuroma. Gas within left cerebellopontine angle cistern caps small cisternal mass, which has enlarged internal auditory canal at porus acusticus. Mass extends about 5 mm from porus acusticus. Routine contrast-enhanced CT scan was suspicious because of asymmetric canal enlargement, but no enhancing tumor was demonstrated.

Fig. 5.—Gas CT cisternography in inflammation of sensory ganglion of cochlear nerve. Gas within right cerebellopontine angle cistern and partially filling internal auditory canal. Soft-tissue density in most lateral aspect of canal prevents complete filling of canal. Border of soft-tissue density is concave to gas. Longitudinal dimension was 3 mm. Although mass lesion was observed and resected at surgery, pathologic examination demonstrated normal sensory ganglion cells with lymphocytic infiltration.

Discussion

The availability of the GE CT/C 8800 high resolution scanner equipped with software capabilities for reconstruction zoom magnification (ReView) improved the performance of CT cisternography [2]. Further, the digitized image for localization of scan cuts through the internal auditory canal greatly shortened the time necessary for diagnostic imaging. Cuts of 1.5 mm through the internal auditory canal coupled with the reconstruction zoom images demonstrated intracanalicular structures such as the neurovascular bundle [3] and the hairpin turn of the anterior inferior cerebellar artery which were never observed in patients examined on the EMI 5005 with a 5 mm slice. The entire procedure, including spinal tap, was easily performed in 30–45 min.

Filtered CO_2 instead of air greatly reduced the frequency of acute headaches. This was due to the very quick resorption of CO_2 from the intracranial cisternal spaces. Digital localization of scan cuts also contributes to the lesser morbidity, since a smaller amount of gas is needed when accurate and fast imaging is accomplished. There was no difficulty with the rapid absorption of CO_2 whether studied by either high or low resolution scanners.

This favorable experience promoted us to examine acoustic neuroma suspects as outpatients. At completion of the procedure, the patient was placed in the recumbent position for 1 hr. If there were no ill effects, the patient was discharged home. The patients were advised to remain recumbent for the rest of the day and to avoid any exertional activities for 2 days. Three of 20 patients so examined had continued headache for 3, 6, and 7 days after the procedure. In one the headache occurred after heavy exertion the day after the procedure. Presumably these prolonged headaches are complications of the spinal tap.

Our series includes four purely intracanalicular acoustic neuromas. Our initial concern, as well as the concern of other investigators [3, 4], that gas CTC as performed might not delineate such lesions has proven to be unfounded, particularly when a high resolution scanner is used.

The four equivocal examinations were made on the EMI 5005 which limits the slice thickness to 5 mm. In three, the examination of a small canal with a 5 mm slice thickness scan made inclusion of adjacent osseous structures unavoidable with resultant poor resolution of intracanalicular gas. Scans with 1.5 mm slice thickness have eliminated this problem. In fact, after one equivocal study, reexamination with the high resolution scanner documented an intracanalicular acoustic neuroma (fig. 3B). The only questionable false-positive study was the case of ganglionitis described above.

The rather low failure rate of gas CTC even when performed on a low resolution scanner, four of 61, will be, in our opinion, further reduced with the use of a high resolution scanner, particularly with digital localization of the internal auditory canal and 1.5-mm-thick slices.

In summary, gas CTC with filtered CO_2 is easily performed, particularly with the use of a high resolution scanner having digital radiographic capability. The examination requires 30–45 min. Patients may be examined on an outpatient basis with limited morbidity. Acute morbidity, which is primarily headache, is markedly reduced with the use of CO_2. Using reconstruction zoom magnification, the intracanalicular segment of the neurovascular bundle is seen in most normal patients.

Gas CTC is the procedure of choice to diagnose a purely intracanalicular acoustic neuroma. Gas CTC has a low failure rate when performed on any scanner, but its sensitivity and the visualization of anatomic structures improve with the use of a high resolution scanner, thin slices, and reconstruction zoom magnification.

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