Comparison of Computed Tomography and Complex Motion Tomography in the Evaluation of Cholesteatoma

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High-resolution axial and coronal computed tomographic (CT) scans were compared with coronal and sagittal complex motion tomograms in patients with suspected middle ear cholesteatomas. Information on CT scans equaled or exceeded that on conventional complex motion tomograms in 16 of 17 patients, and in 11 it provided additional information. Soft-tissue resolution was superior with CT. In 14 patients who underwent surgery, CT provided information that was valuable to the surgeon. On the basis of this study, high-resolution CT is recommended as the preferred method for evaluating most patients with cholesteatomas of the temporal bone.

Anatomic studies have shown that computed tomography (CT) scans that are reconstructed with bone detail algorithms and viewed at a wide window width (3000–4000 H) compare well with complex motion tomographic (CMT) images [1, 2]. CT has the advantage of being able to demonstrate curved or inclined structures better than CMT. In addition, normal soft-tissue structures in the middle ear, including the tympanic membrane, tensor tympani muscle and tendon, and stapedius tendon, cannot consistently be seen on CMT but they can be shown on high-resolution, thin-section CT scans [3]. The improved contrast resolution on CT scans should make CT useful for studying inflammatory disease of the middle ear. The present study was undertaken to determine whether CT should replace CMT for studying suspected cholesteatomas.

Subjects and Methods

Seventeen patients who were suspected of having cholesteatoma and who were expected to undergo surgery had CMT studies in the coronal and sagittal planes at 1–2 mm intervals. Tomograms were taken on the Polytome (Philips Medical Systems, Shelton, CN). Technical factors were as follows: hypocycloidal motion (48° arc), 66–78 kVp, 180–240 mAs, no grid, Dupont Cronex 5P XH screen, and DuPont Cronex 4 film. Fifteen of the 17 patients were also examined in the axial and coronal planes (two were studied only in the axial plane) on the General Electric CT/T 8800 scanner (General Electric Medical Systems, Milwaukee). Scans were done with the 1.5 mm collimator and 1.5 mm table incrementation, producing an actual slice thickness of about 1.8 mm (General Electric Medical Systems, personal communication). Scans were done at settings of 120 kVp and 320 mA, and a 9.6 sec scan time was used. Scans were reconstructed with a bone detail algorithm (ReView) and viewed at a 4000 H window width (−1000 to +3000 H) [4]. Fourteen patients had both CT and CMT before surgery, and three patients had CT and CMT but no surgery.

The tomograms and CT scans were reported independently preoperatively, then both were compared with the operative reports in 14 patients to determine the accuracy of the radiographic findings. The patients had been operated on by many different otologists, so the operative reports were not uniform in their descriptive details. The two radiographic studies were also examined to determine whether CT provided new information not shown on CMT, whether CT led to increased confidence in the tomographic findings, whether there was correlation between CT and CMT, and whether CT was useful to the surgeon.

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Results

Abnormalities were seen in 16 of 17 patients examined by both CMT and CT, but CT provided some new information in 11 of the patients. In 15 of the 17 patients, CT also led to increased confidence in the findings on CMT (table 1). In one of the other two patients, CMT had shown opacification of the mastoid and middle ear. On a CT scan obtained 4 weeks later, these changes had resolved, indicating reduction of an inflammatory process. The other patient had a small attic retraction pocket and cholesteatoma that was not detected on either CT or CMT. There was no instance in which CT led to a misdiagnosis or caused inaccurate interpretation of the tomographic findings. In general, there was good overall correlation of pathologic findings with findings on CT and CMT, even though in some cases new information was seen on CT scans.

TABLE 1: **Features Used to Compare Value of CT and CMT for Studying Cholesteatoma**

Feature	No. Patients	
	Yes	No
New information on CT	11/17	6/17
Increased confidence in CMT	15/17	2/17*
Correlation between CT and CMT	14/17	3/17*
CT useful to surgeon	6/14	1/14

Note.—In seven cases it was indeterminate whether CT was useful to the surgeon. CMT = complex motion tomography.

* 4 week time difference between studies in one patient.

Fourteen patients who had CT of the temporal bone also had ear surgery. CT provided the otologist with useful information in six of these patients. Additional information from CT included sparing of the sinus tympani by a small cholesteatoma, posterior extension of a large cholesteatoma, a small cholesteatomatous mass in the middle ear, improved demonstration of brain herniating though a large surgical defect, and an intact tegmen tympani. In seven patients it could not be determined from the operative reports whether the surgeons gained any additional useful information from the CT scans. In the other patient in this group, the CT scans and CMT images both showed only a slightly blunted drum spur. At surgery this woman had a retraction pocket with a small cholesteatoma that had destroyed only the drum spur. No soft-tissue mass was visible, even with CT.

Five patients had surgery previously in the same ear. CT provided the surgeon with important diagnostic information in three of these five postoperative patients. In one, CT showed that the CMT diagnosis of bone erosion near the sinodural angle was erroneous. In another patient, the vertical part of the facial nerve canal and an area of questionable bone destruction near the posterior genu of the facial nerve were seen better on coronal and sagittal tomograms.

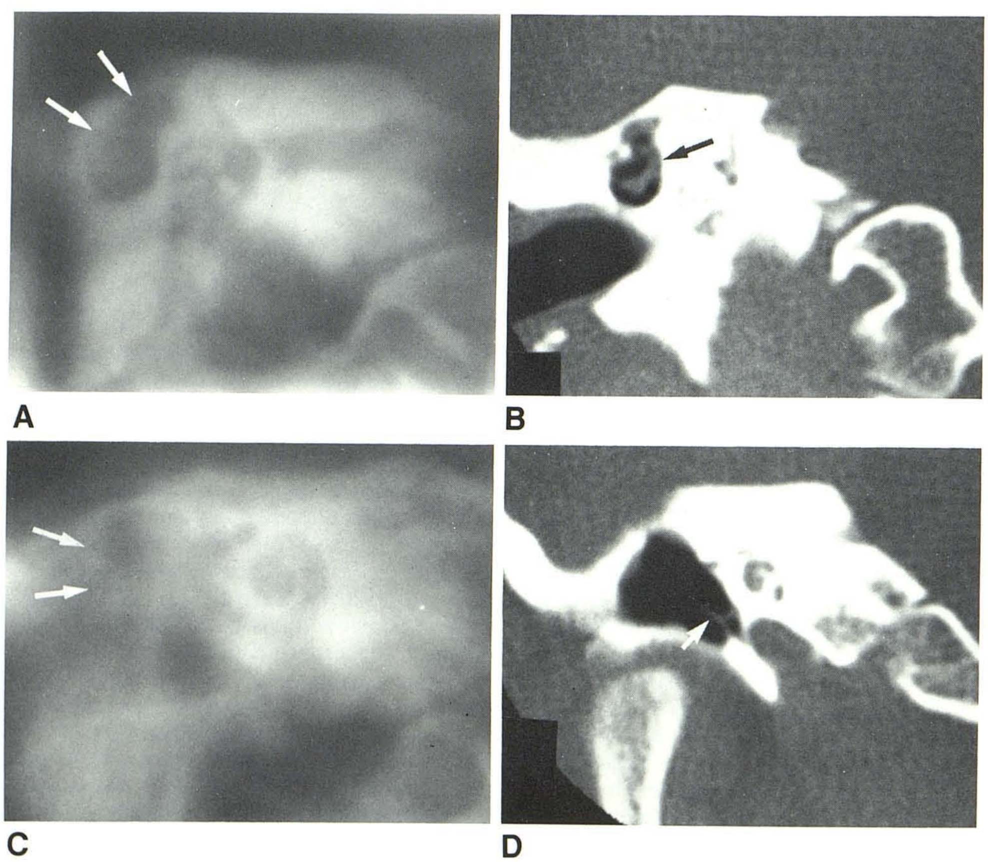

Fig. 1.—Middle-aged woman with long history of tympanic membrane perforation and chronic draining ear. **A,** Coronal tomogram posterior to middle ear cavity. Mastoid antrum is enlarged and smooth-walled (*arrows*). **B,** CT scan at about same level. Cavity is partly filled with soft tissue (*arrow*). **C,** Coronal tomogram 5 mm anterior to **A**. Lateral attic wall is eroded (*arrows*) and middle ear cavity appears partly opaque. **D,** Corresponding CT scan shows that middle ear contains mostly air and that malleus is not seen. Part of thick tympanic membrane is present inferiorly (*arrow*).

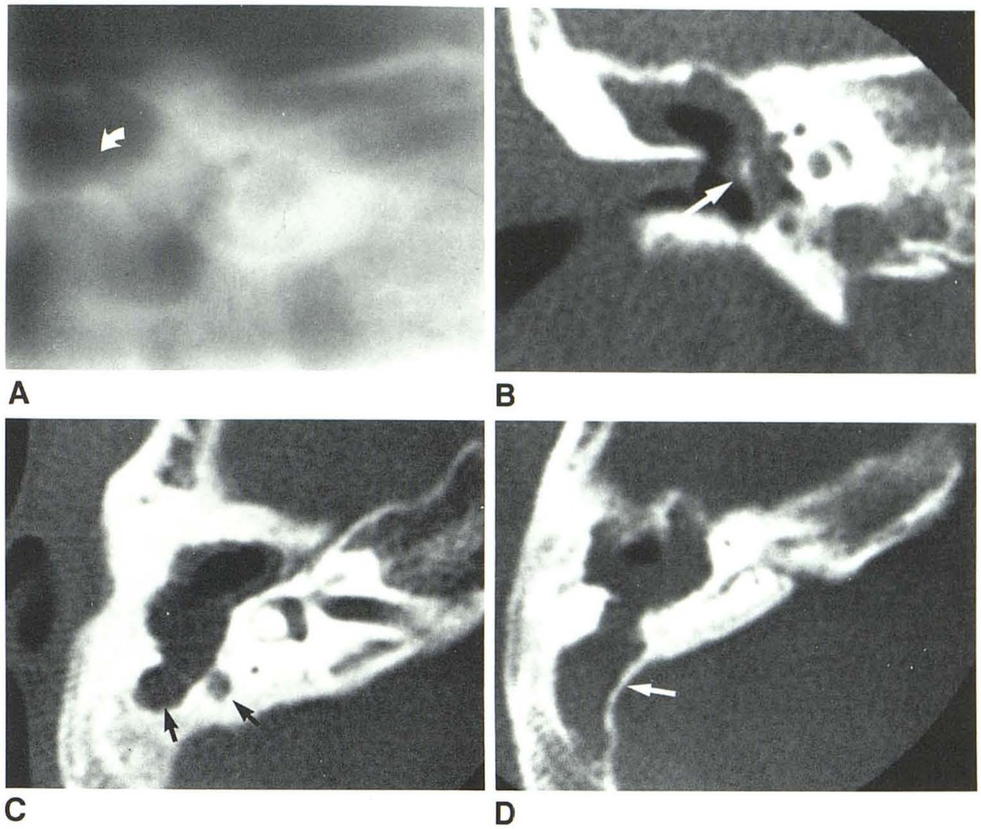

Fig. 2.—Boy with chronic draining right ear who had not had previous mastoidectomy. **A,** Coronal tomogram at level of cochlea. Lateral attic wall is eroded (*arrow*) and there is a poorly defined density in middle ear, which may be malleus. **B,** Coronal CT scan at same level. Distribution of soft tissue and air is detected better. Only a tiny remnant of malleus remains attached to tympanic membrane (*arrow*). **C,** Axial CT scan. Cholesteatoma has eroded bone extensively, particularly posteriorly into mastoid (*arrows*). **D,** Axial scan 6 mm higher than **C**. Large posterior extension of cholesteatoma was not visible on tomograms because this area was not included in either coronal or sagittal tomograms. Only a thin plate of bone separates cholesteatoma from the sigmoid sinus (*arrow*).

Discussion

Acquired cholesteatoma may be concomitant with middle ear inflammatory disease or a complication of it. Cholesteatomas often begin as retraction of the pars flaccida of the tympanic membrane into the epitympanic space (attic); this type of cholesteatoma is the primary acquired cholesteatoma and represents the most common kind of middle ear cholesteatoma. Secondary acquired cholesteatoma occurs when squamous epithelium grows through a perforation in the pars tensa part of the tympanic membrane and becomes trapped in the middle ear [5].

Cholesteatomas characteristically erode the ossicular chain and drum spur (scutum) first. A cholesteatoma may extend anteriorly into the middle ear space or posteriorly into the antrum and mastoid. Cholesteatomas in the mastoid antrum may produce a smooth-walled cavity, eroding Koerner septum [6] (fig. 1). Cholesteatomas also vary in the amount of destruction they cause; some may be relatively quiescent while others may erode a considerable amount of bone.

Previous studies have discussed the usefulness of CT in the diagnosis of cholesteatoma and inflammatory lesions of the middle ear [7–9]. CT and CMT were also compared using dried skulls with simulated cholesteatoma [10]. This study confirms the findings of the previous studies in a larger series of preoperative patients. The axial plane is superior for evaluating the sinus tympani in the posterior middle ear where cholesteatoma is inaccessible to the otologist [11]. Erosion of bone over the horizontal semicircular canal can also be detected better in the axial plane, which is roughly parallel to the plane of the semicircular canal. The axial plane is also best for demonstrating posterior extension of cholesteatoma into the mastoid (fig. 2). Coronal CT scans are necessary to study areas of possible bone erosion such as the tegmen tympani and drum spur, which are not seen well in the axial plane.

A major advantage of CT is that it offers better contrast resolution than CMT. This improved contrast resolution often makes up for the decreased spatial resolution on CT scans. In one patient with a small cholesteatoma, the extent of the soft-tissue mass was demonstrated more accurately on axial CT scans than on coronal and sagittal tomograms. Destruction of the long process of the incus could be seen on both studies, but sparing of the sinus tympani and extension of the cholesteatoma into the attic and aditus could be detected only on the CT scans (fig. 3).

One problem with CMT has been ghost shadows caused by blurring of structures outside the focal plane [2]. These shadows do not occur on CT images [2, 10], so CT evaluation of soft-tissue abnormalities is easier.

In summary, although CT and CMT provide similar information about the temporal bone in many cases, CT is preferred for evaluating patients with cholesteatoma because CT has better contrast resolution of soft tissues without ghost shadows and is easily done in the axial projection, which is the preferred projection for evaluating cholesteatoma in the

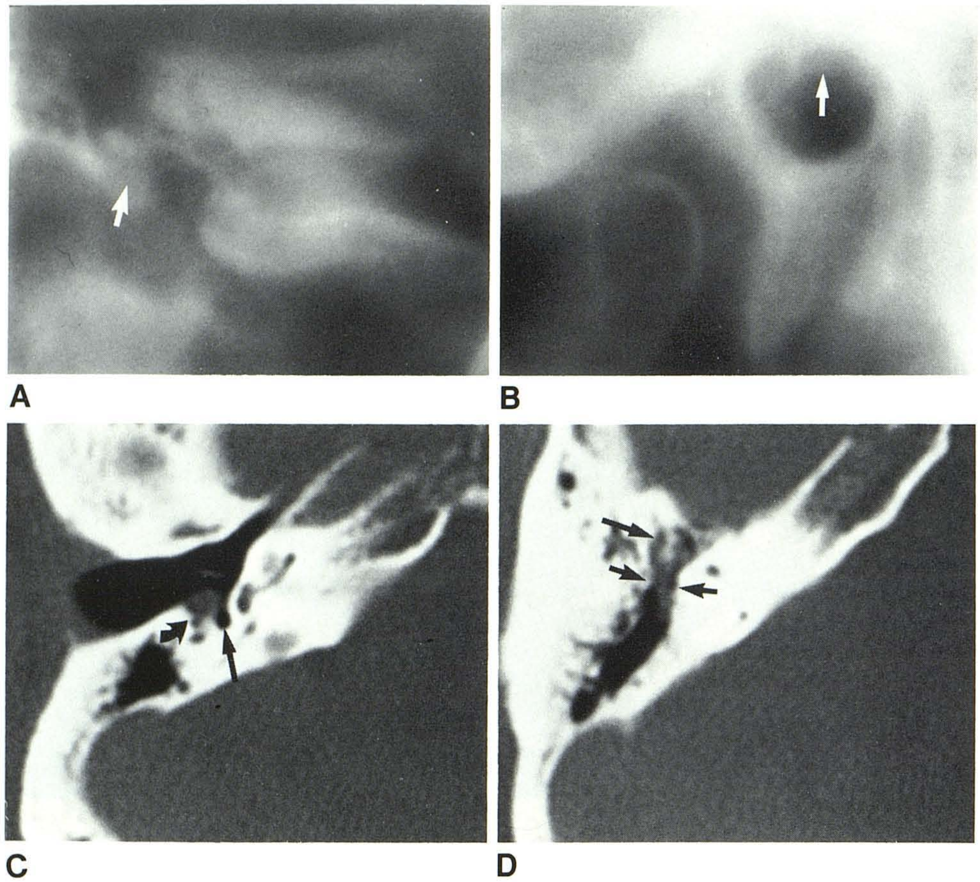

Fig. 3.—Young man with right cholesteatoma who had previous left radical mastoidectomy. **A,** Coronal tomogram at oval window level. There is poorly defined soft-tissue mass in middle ear (*arrow*). **B,** Sagittal tomogram at level of malleus and incus. Long process of incus is eroded (*arrow*). **C,** Axial CT scan through inferior middle ear. Cholesteatoma is in facial recess (*curved arrow*) but not in sinus tympani (*straight arrow*). Long process of incus has been eroded. **D,** Axial scan 6 mm higher than **C**. Soft-tissue density of cholesteatoma surrounds top of malleus and incus (*long arrow*) and extends posteriorly into narrow aditus (*short arrows*). Posteriorly, antrum is clear.

posterior part of the middle ear, bone erosion over the horizontal semicircular canal, and posterior extension of cholesteatoma into the mastoid. CT often provides additional information not available with CMT, thus increasing physicians' confidence in the tomograms. Further, radiation dose to the eyes should be less with CT than with CMT if relatively low milliamperage technique is used and if the scanning beam does not pass through the eyes.

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REFERENCES

1. Beatty CW, Harris LD, Suh KW, Reese DF. Comparative study using computed tomographic thin-section zoom reconstructions and anatomic macrosections of the temporal bone. *Ann Otol Rhinol Laryngol* **1981**;90:643–649
2. Littleton JT, Shaffer KA, Callahan WP, Durizch ML. Temporal bone: comparison of pluridirectional tomography and high resolution computed tomography. *AJR* **1981**;137:835–845
3. Virapongse C, Rothman SLG, Kier EL, Sarwar M. Computed tomographic anatomy of the temporal bone. *AJR* **1982**;139:739–749
4. Shaffer KA, Volz DJ, Haughton VM. Manipulation of CT data for temporal-bone imaging. *Radiology* **1980**;137:825–829
5. Zizmor J, Noyek A. The protean radiologic manifestations of acquired temporal bone cholesteatoma. *J Otolaryngol [Suppl]* **1981**;5:1–41
6. Phelps PD, Lloyd GAS. The radiology of cholesteatoma. *Clin Radiol* **1980**;31:501–512
7. Lloyd GAS, Phelps PD, Du Boulay GH. High-resolution computerized tomography of the petrous bone. *Br J Radiol* **1980**;53:631–641
8. Hanafee WN, Jenkins HA, Mancuso AA, Winter J. Computerized tomography of the temporal bone. *Ann Otol Rhinol Laryngol* **1979**;88:721–728
9. Hanafee WN, Mancuso A, Winter J, Jenkins H, Bergstrom L. Edge enhancement computed tomography scanning in inflammatory lesions of the middle ear. *Radiology* **1980**;136:771–775
10. Lufkin R, Barni JJ, Glen W, Mancuso A, Canalis R, Hanafee W. Comparison of computed tomography and pluridirectional tomography of the temporal bone. *Radiology* **1982**;143:715–718
11. Russell EJ, Koslow M, Lasjaunias P, Bergeron RT, Chase N. Transverse axial plane anatomy of the temporal bone employing high spatial resolution computed tomography. *Neuroradiology* **1982**;22:185–191