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High-Resolution Computed Tomography of Cholesteatomatous Otitis Media: Significance of Preoperative Information

Kee Hyun Park, Soon Il Park,[1] Joon Kwon,[1]
Young Myoung Kim, In Yong Park, and Ki Joon Sung[2]

High resolution computed tomography (CT) of the middle ear and mastoid, when properly performed and interpreted, is valuable to the otologic surgeon prior to exploration of the cholesteatomatous ear. Fifty one patients with cholesteatomatous otitis media underwent CT examination of both ears one to four weeks prior to surgery. These CT findings were then compared with operation findings. We analysed sixteen parameters of the anatomical and pathological features of the temporal bone affected by cholesteatoma. In conclusion, a high degree of correct correlation was noted between CT findings and those of the operation. Our study showed the usefulness and accuracy of preoperative computed tomographic study in cholesteatomatous otitis media.

Key Words: Cholesteatoma, temporal bone computed tomography

Cholesteatoma is a relatively common and potentially dangerous disease of the middle ear cleft. Conventional X-rays often are of little value in the quantitative evaluation of cholesteatoma. There is also a conflict of opinion concerning the role of radiology in the management of cholesteatoma. In many otologic centers, X-ray pictures of the petrous bones are traditionally made in every case of chronic otitis media. This practice constitutes an indefensible waste of money and time and does not in any way assist a competent surgeon. In addition, poor quality X-ray films are of no clinical value and may lead to serious error in the evaluation of a cholesteatoma. Probably the main reason for the disenchantment of some otolaryngologists with temporal bone radiography is that they cannot obtain technically satisfactory films (Buckingham *et al.* 1973).

Recent improvements in CT scanners have made detailed information of the temporal bone available, and certain structures that were previously poorly visible by other methods are now clearly seen. The wealth of anatomic data displayed in various CT projections poses a diagnostic challenge to otologic surgeons and radiologists.

The purpose of this study is to investigate the diagnostic accuracy of the temporal bone CT in cholesteatomatous bone destruction and to apply it as a routine preoperative check for cholesteatoma surgery.

MATERIALS AND METHODS

We analysed 51 cases of cholesteatoma by temporal bone CT 1-4 weeks prior to surgery from March 1986 to February 1988. CT features of each cholesteatoma were compared with the lesion found during surgery. The subjects ranged in age from 11 to 57 years with a mean age of 28.1 years

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Department of Otorhinolarnygology, Yonsei University College of Medicine, Seoul, Korea
Departments of Otolaryngology,[1] and Diagnostic Radiology,[2] Yonsei University Wonju College of Medicine, Wonju, Korea
Address reprint requests to: Dr. K H Park, Department of Otorhinolaryngology, Yonsei University College of Medicine, C.P.O. Box 8044 Seoul, Korea

A Philips Tomoscan 350, with occassionally a soft-ware package of macrovciew, was used in all cases. Sections 1.5mm thick were obtained in continuous and overlapping fashion through the temporal bone in both axial and coronal positions. These sections could be further overlapped is necessary in the vicinity of the oval window for evaluation of the stapes. All sections were targeted for maximal bony detail and sometimes a window setting for the soft tissue was done to determine the extent of cholesteatoma. Contrast enhancement was not helpful. The diagnostic accuracy of CT was discussed on the basis of the following parameters:

1. Extent of cholesteatoma.
2. Erosion and/or destruction of the outer wall structure which included the lateral attic wall, posterior canal wall, and mastoid lateral wall.
3. Erosion and/or destruction of the dural plate which included the tegmen tympani, tegmen mastoideum, and lateral sinus plate.
4. Erosion and/or destruction of the three ossicles.
5. Exposure of the facial nerve which included the tympanic portion, mastoid portion, and second genu portion.
6. Fistula of the three semicircular canals.

We studied the sensitivity, specificity and predictability fo each parameter. With the diagnostic accuracy of CT we could determine the predictability which revealed the percentage of agreement for both positive and negative findings at surgery.

RESULTS

Diagnostic accuracy of the extent of cholesteatoma (Table 1).

The cholesteatomatous sac is a soft tissue lesion and appears in the CT as a soft tissue shadow. Granulation tissue has the same CT attenuation number as the cholesteatomatous sac, and thus the involved portion of the epitympanum and mastoid cavity showed similar soft tissue density of the cholesteatoma and granulation tissue (Figs. 1, 2).

Table 1. Diagnostic accuracy of cholesteatoma extent

Sensitivity	92.5% (37/40)
Specificity	0.0% (0/11)
Predictability	72.5% (37/51)

Diagnostic accuracy of destruction of the outer wall structure (Table 2).

Cholesteatomas, when very extensive, characteristically erode the bony outer wall structure of the middle ear cleft and the amount of erosion depends on the site and size of the cholesteatoma. The CT revealed bony erosion and/or destruction of

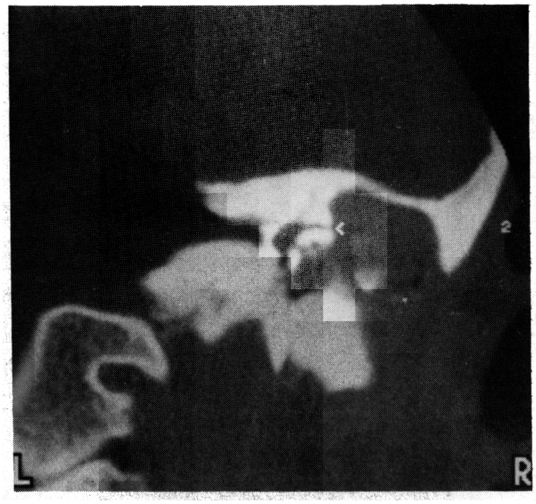

Fig. 1. *Coronal section, Right ear. Soft tissue density occupies the whole mastoid cavity and the fistula of the lateral semicircular canal is noted (<).*

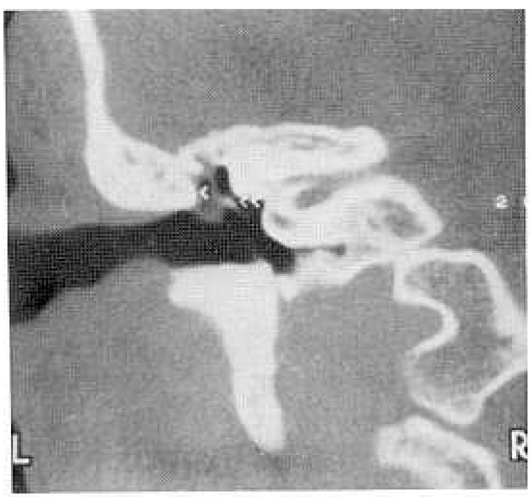

Fig. 2. *Coronal section, Left ear. Soft tissue density is localized at the attic in which the lateral wall is blunted (<), and the long process of the incus is only noted (<<).*

Table 2. Diagnostic accuracy of destruction of outer wall structure

	Lateral attic wall	Posterior canal wall	Mastoid lateral wall
Sensiticity	100.0% (38/38)	100.0% (16/16)	100.0% (12/12)
Specificity	69.2% (9/13)	100.0% (35/35)	100.0% (39/39)
Predictability	92.1% (47/51)	100.0% (51/51)	100.0% (51/51)

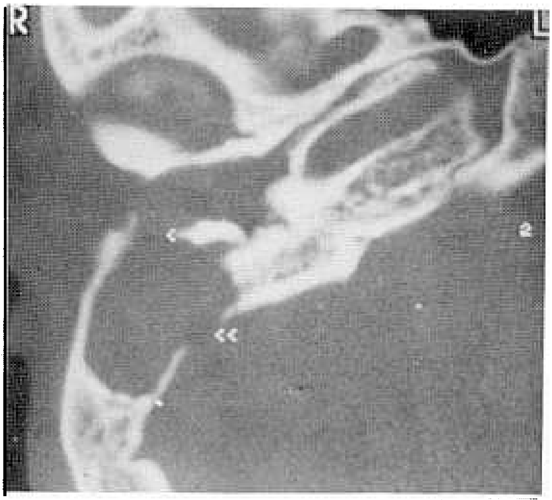

Fig. 3. *Axial section, Right ear. The mastoid cavity is filled with soft tissue mass. The posterior canal wall (<) and the lateral sinus plate (<<) are destroyed.*

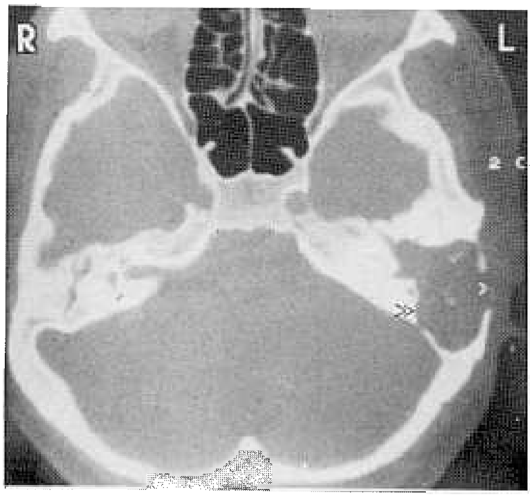

Fig. 4. *Axial section, Left ear. A well advanced cholesteatoma that extends into the antrum destroys the mastoid lateral wall (<) and erodes the superior and posterior semicircular canal (<<).*

Table 3. Diagnostic accuracy of destruction of dural plate

	Tegmen tympani	Tegmen mastoideum	Sigmoid sinus plate
Sensitivity	80.0% (4/ 5)	100.0% (9/ 9)	100.0% (6/ 6)
Specificity	91.3% (42/46)	92.9% (39/42)	100.0% (45/45)
Predictability	90.2% (46/51)	94.1% (48/51)	100.0% (51/51)

the lateral attic wall, posterior canal wall, and mastoid lateral wall (Figs. 2, 3, 4).

Diagnostic accuracy of destruction of the dural plate (Table 3).

Extension of the cholesteatomatous sac into the whole middle ear cleft resulted in erosion or destruction of the dural plates over the tegmen and lateral sinus (Figs. 3, 5). CT in the axial plane can show any defect in the bony plate covering the lateral sinus. Defects of the tegmen are well visualized in the coronal view.

Diagnostic accuracy of destruction of the ossicles (Table 4).

High resolution CT showed the malleus and incus well, and it also clearly showed any erosion or displacement of these ossicles by a cholesteatoma (Fig. 2). The stapes was less well seen in the usual continuous sections, but these sections could be further

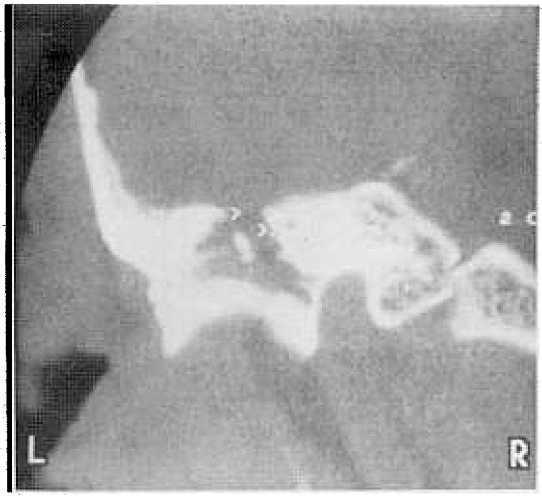

Fig. 5. *Coronal section, Left ear. Extension of cholesteatoma results in destruction of the dural plate over the tegmen (<) and the tympanic portion of the facial nerve is exposed (<<).*

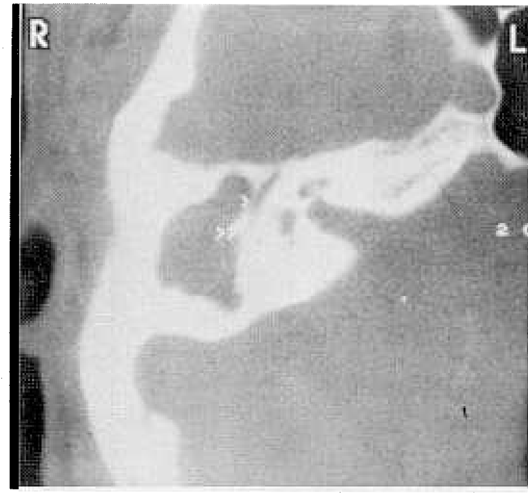

Fig. 6. *Axial section, Right ear. The bony canal of the tympanic portion of the facial nerve is eroded (<), and the second genu portion and a part of the mastoid segment of the facial nerve are exposed (<<).*

Table 4. Diagnostic accuracy of destruction of ossicles

	Malleus	Incus	Stapes
Sensitivity	97.7% (42/43)	100.0% (47/47)	97.1% (34/35)
Specificity	62.5% (5/ 8)	25.0% (1/ 4)	75.0% (12/16)
Predictability	92.2% (47/51)	94.1% (48/51)	89.5% (46/51)

Table 5. Diagnostic acuracy of exposure of facial nerve

	Tympanic part	Mastoid part	Second genu part
Sensitivity	94.1% (16/17)	60.0% (3/5)	100.0% (4/ 4)
Specificity	73.5% (25/34)	100.0% (46/46)	89.4% (42/47)
Predictability	80.4% (41/51)	96.1% (49/51)	90.2% (46/51)

Table 6. Diagnostic accuracy of fistula of semicircular canal

	Lateral	Superior	Posterior
Sensitivity	100.0% (15/15)	– (0/ 0)	0.0% (0/ 1)
Specificity	86.1% (31/36)	94.1% (48/51)	98.0% (49/50)
Predictability	90.2% (46/51)	94.1% (48/51)	96.1% (49/51)

overlapped in the vicinity of the oval window for better evaluation.

Diagnostic accuracy of exposure of the facial nerve (Table 5).

CT showed the bony facial canal eroded by a cholesteatoma at the tympanic and mastoid portion (Figs. 5, 6). This erosion occurred most commonly on the tympanic portion of the facial nerve where the bony canal is normally very thin. These erosions of the bony facial canal should be visible from both the axial and coronal view and should alert the surgeon to the possibility of damaging the facial nerve during surgery, even when the erosion has not caused facial palsy.

Diagnostic accuracy of fistula of the semicircular canal (Table 6).

A far advanced cholesteatoma that extended into the antrum eroded the lateral semicircular canal with formation of a labyrinthine fistula (Fig. 1) and destroyed the superior and posterior semicircular canal (Fig. 4).

DISCUSSION

Since its introduction and clinical application in 1973 (Ambrose 1973), CT has made enormous contributions in the areas of diagnostic medicine, treatment planning, and follow-up. During this same period, advances in CT technology and image quality have evolved at a staggering rate. In the beginning of the 1980's, with the recent development of high resolution CT, there was a growing need to explore the full potential of this new method in demonstrating the detailed anatomy of the temporal bone. Swartz *et al.* (1983, 1984) have clearly demonstrated the value of high resolution CT for all aspects of the temporal bone, and most of the temporal bone pathologies, including cholesteatoma, have been studied with this new method. Using multidirectional tomography, Valvassori *et al.* (1982) have already studied its usefulness in the evaluation of cholesteatomas. They pointed out that preoprative identificatoin of labyrinthine fistulae helped to avoid cochlear losses. The type of surgery to be done, open or closed, will often depend on the tomographic studies. If the lateral attic wall is markedly eroded, closed mastoidectomy may be impossible. The coronal projection is superior to the axial with better delineation of the lateral attic wall. Knowledge of ossicular erosion and/or destruction enables the surgeon to prepare proper homografts when reconstruction is planned. Thus, CT assessment of cholesteatoma gives us considerable preoperative information. In a paper which evaluated patients for possible cholesteatoma, CT findings were consistent with surgical findings in 92% of the cases (Zalzal *et al.* 1986).

Preoperative diagnostic accuracies of CT were generally very high for all parameters in our study. In all but two parameters, predictability was over 90%. In the first case, predictability of the status of the tympanic portion of the facial nerve was relatively low because the bony canal was confirmed to be paper-thin at operation, and this was not detected by CT. This is because even a 0.5mm overlapping section has the limitation of spatial resolution on CT. Another cause of low diagnostic accuracy of the status of the tympanic portion of the facial nerve was thought to be a slightly high incidence of congenital dehiscence of that canal itself.

In the second case, relatively low predictability for cholesteatoma extension was caused by frequent difficulty in making a differential diagnosis between cholesteatoma and granulation tissue. This might be impossible even though various window settings for soft tissue were available. There was a cholesteatoma limited to the epitympanum, but the adjacent antrum was filled with granulation tissue. Radiographically, it appeared that both the epitympanum and the antrum had a cholesteatoma. Granulation tissue is usually seen on CT as a non- dependent soft tissue density; however, the distribution and method of spread of granulation tissue is different from that of a cholesteatoma and more eroded and/or destructive surrouinding bony wall or ossicles are noted in the case of cholesteatoma. While the CT scan could not tell the exact size of the sac, it clearly showed that the epitympanum and the antrum were involved in a pathologic process, and thus surgical intervention would likely be no problem.

CONCLUSIONS

The diagnostic accuracy of preoperative CT in cholesteatomatous otitis media was very high. Therefore, CT could help us not only to avoid intraoperative complications, but also to decide the appropriate type of surgery and to choose ossiculoplastic materials preoperatively. Routine axial and coronal scanning without enhancement takes only 30 to 40 minutes with cooperative patients. It is, therefore, a practical preoperative procedure, even in a busy department.

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