High-resolution CT of the normal and abnormal fallopian canal.

A Valavanis, S Kubik and O Schubiger

AJNR Am J Neuroradiol 1983, 4 (3) 748-751
http://www.ajnr.org/content/4/3/748

High-Resolution CT of the Normal and Abnormal Fallopian Canal

Anton Valavanis,[1] Stefan Kubik,[2] and Othmar Schubiger[3]

A two-part anatomic and clinical high-resolution computed tomographic (HRCT) study of the fallopian canal was conducted. From the correlation of HRCT images of eight specimen temporal bones with their corresponding anatomic sectional images, it was evident that the full length of the fallopian canal can be accurately visualized. An axial section demonstrates the labyrinthine segment, geniculate ganglion fossa, and proximal part of the tympanic segment, whereas a Stenver projection is used for the tympanic segment, second knee, and mastoid segment. In clinical studies axial sections simultaneously visualized the proximal parts of the fallopian canal in 82% of 28 cases, whereas Stenver projections simultaneously visualized the distal parts in 75% of 16 cases of acute facial nerve palsy. Twenty-one patients with intratemporal facial nerve palsy and six patients with congenital atresia of the external auditory canal were also examined. HRCT was highly accurate in detecting and defining neoplastic, inflammatory, and congenital lesions of the fallopian canal. A lower rate of detection was recorded for traumatic lesions.

After the introduction of high-resolution computed tomography (HRCT) in clinical radiologic practice and its application to the study of the temporal bone, preliminary reports emphasized its high accuracy in visualizing normal intratemporal anatomy [1–5] and in detecting various intratemporal lesions [1, 2, 6]. However, the fallopian or facial nerve canal received little attention, although its anatomy and pathology are partly covered in more general reports on HRCT of the temporal bone [4, 5, 7]. We present briefly the normal appearance of the fallopian canal on HRCT and analyze the value of HRCT in detecting and further defining the various types of lesions involving the fallopian canal.

Materials, Subjects, and Methods

Anatomic Studies

The temporal bones in five cadaver heads and three exarticulated temporal bone specimens were scanned in various planes: (1) axial sections parallel to the infraorbitomeatal line (Reid base line), (2) axial sections parallel to the orbitomeatal line, (3) axial sections parallel to a line from the glabella to the superior border of the zygomatic arch (glabellozygomatic line), (4) coronal sections perpendicular to the infraorbitomeatal line, and (5) Stenver sections. The scanning planes for each section were marked on the surfaces of the cadaver heads and the temporal bone specimens, respectively, with the help of the laser beam. All the temporal bones were then sectioned with the microtome at the marked levels.

Clinical Studies

A series of 55 patients was examined by HRCT for demonstration of the fallopian canal.

Twenty-eight patients presented with acute facial nerve palsy. On the basis of the clinical and laboratory examinations a diagnosis of idiopathic (Bell) palsy or Ramsey-Hunt syndrome was made. These patients were investigated by HRCT either for exclusion of a tumor involving the fallopian canal or for measurement of the meatal foramen of the fallopian canal, which represents the site of strangulation of the facial nerve in 94% of cases with Bell palsy [8, 9]. The results of these measurements will be reported at a later date, since the study has not been completed. HRCT images on these patients were obtained in axial and coronal planes. In 16 patients additional images were obtained in the Stenver projection. These images formed the basis for the study of the normal fallopian canal.

Sixteen patients presented with progressive peripheral facial nerve palsy. Five patients presented with complete (two cases) or incomplete (three cases) posttraumatic peripheral facial nerve palsy. Six patients without facial nerve palsy were examined by HRCT because of congenital atresia of the external auditory canal.

Both the anatomic and clinical HRCT examinations were performed with 2 mm collimation overlapping at 1 mm. Patients with progressive peripheral facial nerve palsy were studied after prescan bolus injection and interscan infusion of meglumine ioxithalamate 30% (Telebrix 30R) with a total iodine content of 60 g.

Results

Normal Fallopian Canal on HRCT

From the HRCT-anatomic correlative study it was evident that for adequate visualization of individual segments of the fallopian canal, sections must be obtained in various planes. However, the full length of the canal can be demonstrated with only two sections: An axial section at the level of the glabella and parallel to the superior border of the zygomatic arch visualizes the labyrinthine segment, geniculate ganglion fossa, and proximal part of the tympanic segment (fig. 1). A Stenver projection at the level of a line from the

[1]Department of Diagnostic Radiology, University Hospital, 8091 Zürich, Switzerland. Address reprint requests to A. Valavanis.
[2]Department of Anatomy, University of Zürich, Zürich, Switzerland.
[3]Department of Diagnostic Radiology, Kantonsspital, 5001 Aarau, Switzerland.

AJNR 4:748–751, May/June 1983 0195–6108/83/0403–0748 $00.00 © American Roentgen Ray Society

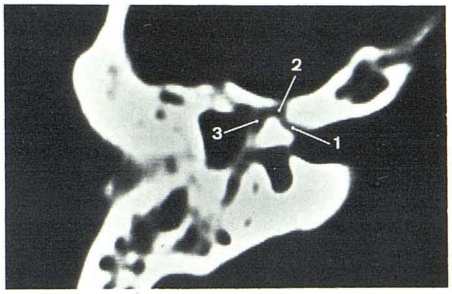
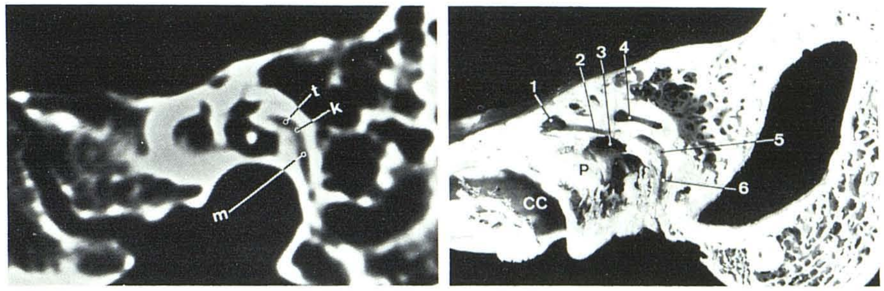
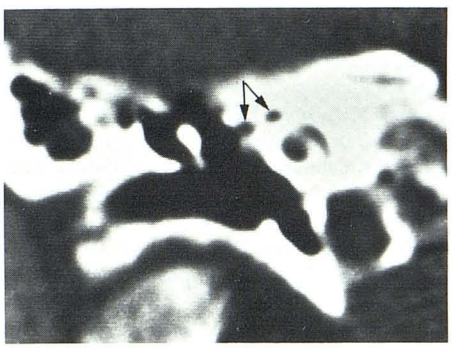


Fig. 1.—HRCT of left temporal bone specimen. Axial section parallel to glabellozygomatic line. Simultaneous visualization of labyrinthine segment (1), geniculate ganglion fossa (2), and tympanic segment (3) in their full length.

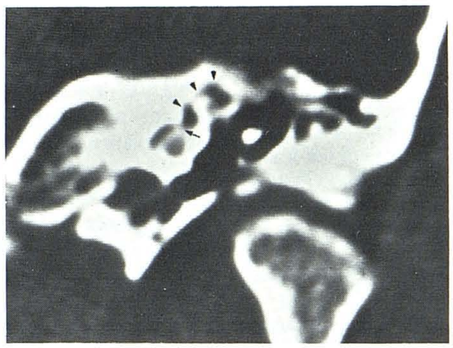


A B

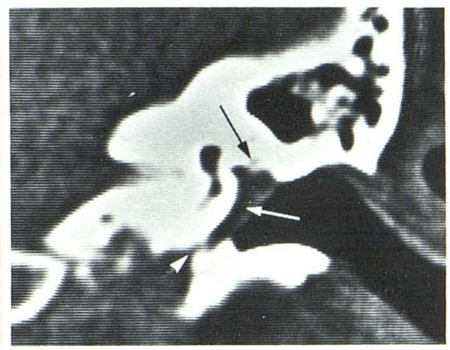
Fig. 2.—**A**, HRCT of left temporal bone specimen. Stenver projection parallel to line from outer margin of contralateral orbit to ipsilateral mastoid process. Simultaneous visualization of tympanic segment (t) coursing below horizontal semicircular canal; second knee (k); and descending mastoid segment (m) in their full length. **B**, Anatomic section corresponding to **A**. Geniculate ganglion fossa (1), tympanic segment (2), oval window (3), horizontal semicircular canal (4), second knee of fallopian canal (5), mastoid segment (6), tympanic promontory (P), and carotid canal (CC).



3



4



5

Fig. 3.—HRCT of right temporal bone in patient with normal fallopian canal. Geniculate ganglion fossa (*double arrow*) in cross section.

Fig. 4.—Intrinsic tumor (hemangioma) of fallopian canal at level of geniculate ganglion fossa. Left side, coronal section. Significant enlargement of geniculate ganglion fossa (*arrowheads*) and circumscribed erosion of its inferior cortical outline (*arrow*).

Fig. 5.—Glomus tumor of left temporal bone involving tympanic segment of fallopian canal. Coronal section. Erosion of cortical outline of jugular fossa (*arrowhead*), tumor mass in middle ear (*white arrow*), and involvement of tympanic segment (*black arrow*) by tumor.

outer margin of the contralateral orbit to the ipsilateral mastoid process visualizes the tympanic segment, the second (or inner) knee, and the mastoid segment (fig. 2).

A coronal section at the cochlear level visualizes the geniculate ganglion fossa in cross section (fig. 3). Consecutive coronal slices posterior to the cochlear level visualize the tympanic segment in cross section. The frequency of HRCT visualization of each segment of the fallopian canal in various planes in the clinical study is summarized in table 1.

Abnormal Fallopian Canal on HRCT

Tumors. Of the 16 patients who presented with progressive peripheral facial nerve palsy, 13 had fallopian canal tumors demonstrated by HRCT. Tumors originating in the fallopian canal caused enlargement and erosion of the involved segment. This was demonstrated in a facial nerve neuroma and a cavernous hemangioma, both occurring at the level of the geniculate ganglion fossa (fig. 4). Tumors involving the fallopian canal secondarily were located eccentric to the involved segment, either in the supralabyrinthine area, the middle ear cavity, or the mastoid part of the temporal bone. They caused erosion or complete destruction of the corresponding segment of the canal. This was demonstrated in three congenital cholesteatomas involving the labyrinthine segment and geniculate ganglion fossa, five glomus tumors involving either the tympanic (fig. 5) or mastoid segment, two middle ear carcinomas involving the tympanic segment, and one metastasis from a breast carcinoma, involving the geniculate ganglion fossa.

Inflammatory lesions. Three of the 16 patients with progressive peripheral facial nerve palsy had inflammatory lesions of the fallopian canal on HRCT. HRCT demonstrated erosion of the proximal tympanic segment of the canal in two cases with secondary cholesteatoma. In one case of malignant external otitis, osteolytic destruction of the distal part of the mastoid segment was evident.

Traumatic lesions. Of five patients with traumatically induced peripheral facial nerve palsy, HRCT demonstrated the site of involvement of the fallopian canal by the fracture line in three. In two patients longitudinal fractures of the temporal bone were found. In these cases the fallopian canal lesion was at the level of the geniculate ganglion (fig. 6). In one patient a transverse fracture was demonstrated in the internal auditory canal near the fundus.

Congenital ear malformations. Of six patients with congenital atresia of the external auditory canal who underwent HRCT for middle ear evaluation, an abberant course of the fallopian canal was found in two, whereas the canal appeared normal in the other four patients. In the two abnormal cases the tympanic segment was significantly shortened, the mastoid segment was situated anteriorly and coursed in a lateral direction, and the exit foramen of the canal was located in the lateral atretic plate (fig. 7).

Discussion

To evaluate patients with intratemporal facial nerve palsy, visualization of the entire course of the fallopian canal is necessary. Sections must be obtained both parallel to the longitudinal axis of the canal and at right angles to the canal. Since each of its three segments courses in a different direction, adequate longitudinal and cross-sectional visualization theoretically necessitates performing different projections for each segment. But if this were done, the duration of the examination and irradiation exposure would increase unjustifiably.

From the anatomic part of this study it was evident that visualization of the full length of the fallopian canal can in fact be achieved with only two projections. An axial section parallel to a line joining the glabella and the superior border of the zygomatic arch visualizes the labyrinthine segment, geniculate ganglion fossa, and proximal part of the tympanic segment simultaneously (fig. 1). This was achieved in 82% of the 28 patients examined with a normal canal (table 1). Patient movement, head asymmetry, and inappropriate gantry angulation were the reasons for failure to simultaneously visualize these three parts of the canal in the other 18% of the patients. A Stenver projection parallel to a line from the outer margin of the contralateral orbit to the ipsilateral mastoid process visualizes the tympanic segment, second knee, and mastoid segment simultaneously (fig. 2). This was achieved in 75% of the 16 patients examined with a normal fallopian canal.

TABLE 1: **Frequency of Visualization of Segments of Fallopian Canal in Various CT Scanning Planes**

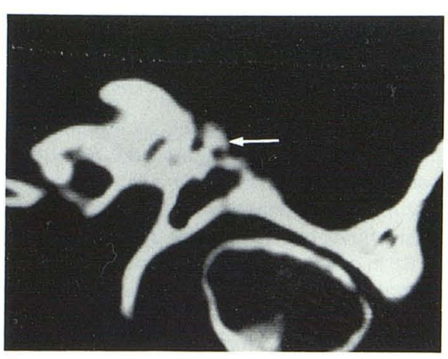
Segment(s) of Fallopian Canal	Sectional Plane of Segment	CT Projection	Frequency of Visualization (%)
Ls	Longitudinal	Axial	25/28 (89.3)
Ggf	Longitudinal	Axial	28/28 (100.0)
Ggf	Cross section	Coronal	28/28 (100.0)
Ts(pp)	Longitudinal	Axial	23/28 (82.1)
Ts	Cross section	Coronal	16/28 (57.1)
Ts	Longitudinal	Stenver	12/16 (75.0)
Ms	Cross section	Axial	28/28 (100.0)
Ms	Longitudinal	Coronal	22/28 (78.6)
Ms	Longitudinal	Stenver	15/16 (93.7)
Ls + ggf + ts(pp)	Longitudinal	Axial	23/28 (82.1)
Ts + ms	Longitudinal	Stenver	12/16 (75.0)

Note.—Twenty-eight patients with Bell palsy or Ramsey-Hunt syndrome were scanned in axial and coronal planes; 16 of these patients were also imaged in the Stenver projection. Ls = labyrinthine segment; ggf = geniculate ganglion fossa; ts = tympanic segment; (pp) = proximal part; ms = mastoid segment.

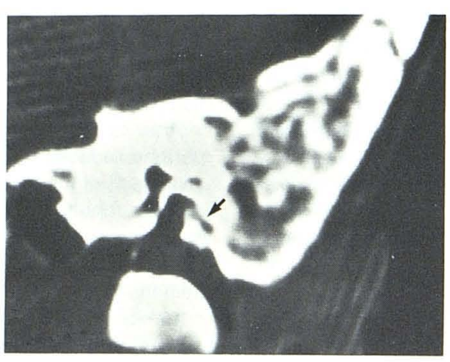
We obtain CT scans in the Stenver projection by placing the patient prone on a specially constructed head and body holder with the patient's axis deviating 20° from the axis of the CT table. The head is hyperextended and rotated 25° toward the contralateral side. However, optimal Stenver projections generally cannot be performed in older patients with cervical spondylarthritis who lack the ability to adequately hyperextend and rotate the head. This was the main reason for the relatively high technical failure rate (25%) in simultaneously visualizing the tympanic and mastoid segments of the canal in this series (table 1).

It is evident from table 1 that the frequency of visualization of each segment of the fallopian canal is higher in axial than in coronal sections. The lowest visualization rate was observed for the tympanic segment in coronal sections (57.1%). This is not surprising, since the tympanic segment is frequently dehiscent and courses obliquely with respect to the coronal plane [10].

For exact determination of the accuracy of HRCT in detecting and defining intratemporal lesions, comparative studies with hypocycloidal tomography are necessary. The earliest patients studied in this series were examined by both HRCT and hypocycloidal tomography. However, it soon became apparent that continuation of this protocol could not be justified. Information obtained from HRCT was either equal to or greater than that obtained from hypocycloidal tomography. Performance of hypocycloidal tomography in patients with intratemporal facial nerve palsy was therefore discontinued. All tumors involving the fallopian canal in this series were detected by HRCT. Intrinsic tumors of the canal most often originate in the geniculate ganglion [11, 12]. The three most common intrinsic tumors of the fallopian canal are neurinoma, hemangioma, and meningioma [11]. Both intrinsic tumors seen in our series caused enlargement of the geniculate ganglion fossa and erosion of its cortical outline (fig. 4). Adjacent thin, overlapping slices show the degree of extension of the tumor along the labyrinthine and the tympanic segments of the canal, since the involved segments appear slightly enlarged as compared with the contralateral normal side. In one patient with progressive peripheral facial nerve palsy—not yet operated upon and therefore not included in this series—HRCT showed enlargement of the labyrinthine segment and geniculate ganglion fossa. On repeat sections after intravenous contrast infusion, significant enhancement was evident in the enlarged part of the fallopian canal. A highly vascular intrinsic tumor was diagnosed. Although we have not yet obtained histologic confirmation of the CT diagnosis in this particular case, we recommend



6



7

Fig. 6.—Longitudinal fracture of left temporal bone involving geniculate ganglion fossa. Coronal section. Superolaterally displaced fragment of roof of geniculate ganglion fossa (*arrow*).

Fig. 7.—Aberrant course of mastoid segment of fallopian canal in congenital atresia of external auditory canal. Left ear, coronal section. Mastoid segment (*arrow*) courses abnormally in a downward, lateral direction.

contrast administration in performing HRCT in patients with progressive peripheral facial nerve palsy.

Extrinsic tumors secondarily involving the fallopian canal include congenital cholesteatoma, glomus tumor, middle ear carcinoma, rhabdomyosarcoma, and metastasis [11, 12]. All extrinsic tumors in this series were detected by HRCT and the site of involvement of the canal could be identified in every case. While involvement of the labyrinthine segment and geniculate ganglion fossa by supralabyrinthine tumors, especially congenital cholesteatoma, is usually easily identified, demonstration of involvement of the tympanic segment by middle ear tumors (e.g., glomus tumor or middle ear carcinoma) may be difficult (fig. 5).

The value of HRCT in evaluating inflammatory lesions of the middle ear has been previously demonstrated [6]. HRCT is not being performed in our institution in cases of acute otitis media. Since the lesion in these cases is usually localized in front of a dehiscent fallopian canal above the oval window or at the level of the cochleariform process, transmastoid decompression of the canal is performed if degeneration of motor nerve fibers is 90% or more as measured by electroneurography within 6 days of onset of the palsy [12]. In cases of chronic otitis media complicated by secondary cholesteatoma, HRCT proved highly accurate in detecting erosion or destruction of the fallopian canal.

Involvement of the facial nerve occurs in 40% of transverse and in 20% of longitudinal fractures of the temporal bone [12, 13]. In transverse fractures fallopian canal involvement occurs at the labyrinthine or tympanic segment, while involvement of the geniculate ganglion fossa is rare [12]. In longitudinal fractures fallopian canal involvement occurs in the region of the geniculate ganglion fossa or distal to the pyramidal turn [12]. HRCT clearly demonstrated the site of canal involvement in three cases in our series (fig. 6), but failed to do so in two other cases. Our series was too small to permit conclusions to be drawn about frequency of visualization of temporal bone fractures and of the site of involvement of the fallopian canal. But on the basis of our limited experience and earlier reports [2], it can be suggested that HRCT will detect traumatic lesions at least as frequently as hypocycloidal tomography.

Isolated congenital anomalies of the fallopian canal involve its size (e.g., hypoplasia, partial or complete agenesis) and its course (e.g., inferior displacement of the horizontal segment). The course of the canal may also be involved in generalized congenital malformations of the ear. Aberration of the course of the canal in its mastoid and tympanic segments may be present especially in cases of congenital atresia of the external auditory canal. In these cases an anteriorly situated and laterally coursing fallopian canal is seen. In two cases in our series HRCT demonstrated the abnormal course of the canal (fig. 7), while in four other cases a normal canal was seen. HRCT is likely to replace conventional tomography in the evaluation of congenital ear malformations.

REFERENCES

1. Lloyd GAS, du Boulay GH, Phelps PD, Pullicino P. The demonstration of the auditory ossicles by high resolution CT. *Neuroradiology* **1979**;18:243–248
2. Lloyd GAS, Phelps PD, du Boulay GH. High resolution computerized tomography of the petrous bone. *Br J Radiol* **1980**;53:631–641
3. Beaty CW, Suh KW, Harris LD, Dubois P. Comparative study using computed tomographic thin-section zoom-reconstructions and anatomic macrosections of the temporal bone. *Ann Otol Rhinol Laryngol* **1981**;90:643–649
4. Russel EJ, Koslow M, Lasjaunias P, Bergeron RT, Chase N. Transverse axial plane anatomy of the temporal bone employing high spatial resolution computed tomography. *Neuoradiology* **1982**;22:185–192
5. Littleton JT, Schaffer KA, Callahan WP, Durizch ML. Temporal bone: comparison of pluridirectional tomography and high resolution computed tomography. *AJR* **1981**;137:835–845
6. Hanafee WN, Mancuso A, Winter J, Jenkins H, Bergstrom LV. Edge enhancement computed tomography scanning in inflammatory lesions of the middle ear. *Radiology* **1980**;136:771–779
7. Hanafee W. Computerized tomographic scan and the facial nerve. In: Graham MD, House WF, eds. *Disorders of the facial nerve. Anatomy, diagnosis and management.* New York: Raven, **1982**;93–98
8. Fisch U. Diagnostic studies on idiopathic facial palsy. In: Shambaugh GE, Shea JJ, eds. *Proceedings of the Shambaugh 5th international workshop on middle ear microsurgery and fluctuant hearing loss.* Huntsville, AL: Strode, **1977**:219–224
9. Fisch U. Total facial nerve decompression and electroneuronography. In: Silverstein H, Norrell H, eds. *Neurological surgery of the ear.* Birmingham, AL: Aesculapius, **1977**:21–23
10. Wilbrand HF. Multidirectional tomography of the facial canal. *Acta Radiol [Diagn]* (Stockh) **1975**;16:654–672
11. Fisch U, Rüttner J. Pathology of intratemporal tumors involving the facial nerve. In: Fisch U, ed. *Facial nerve surgery.* Birmingham, AL: Aesculapius, **1977**:448–456
12. Fisch U. Management of intratemporal facial palsy. In: Kraybühl H, ed. *Advances and technical standards in neurosurgery.* New York: Springer-Verlag, **1980**:215–238
13. Fisch U. Facial paralysis in fractures of the petrous bone. *Laryngoscope* **1974**;84:2141–2154