# Surface-Coil Magnetic Resonance Imaging of the Internal Auditory Canal

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# Surface-Coil Magnetic Resonance Imaging of the Internal Auditory Canal

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**Computed tomography is effective for detecting acoustic neuromas, but not for resolving individual nerves in the internal auditory canal. Surface-coil magnetic resonance (MR) images of the internal auditory canal were obtained using a 1.5 T superconducting magnet, a 13.5-cm-diameter surface coil, 3- and 5-mm-thick slices, and partial-saturation pulse sequences. Cranial nerves VII and VIII (three branches) were identified on MR images in volunteers and on corresponding cryomicrotomic sections. The nerves were obscured in one patient with an acoustic neuroma. Because high-resolution surface-coil images can demonstrate specific nerves in the internal auditory canal, MR should be a sensitive study to evaluate cranial nerves VII and VIII in patients with facial paralysis and neurosensory hearing loss that is congenital or caused by small acoustic neuromas.**

The effectiveness of magnetic resonance (MR) images in demonstrating the normal and abnormal contents of the internal auditory canal and cranial nerve VII in the petrous bone has been described, but the resolution of specific nerves in the internal auditory canal has not [1–4]. Surface-coil images have increased the signal-to-noise ratio and the potential to identify individual nerves in the internal auditory canal in contrast to cortical bone and cerebrospinal fluid (CSF), which have negligible signals. Our purpose is to describe the MR appearance of these nerves.

## Materials and Methods

Three fresh frozen cadaver heads were sectioned using a cryomicrotome and a previously described technique [5]. The surfaces of the specimens were serially photographed. In these anatomic sections, the branches of cranial nerves VII and VIII and structures in the petrous bone, including the geniculate ganglion, cochlea, vestibule, and greater superficial petrosal nerve, were identified by reviewing anatomic, computed tomographic (CT), and MR literature [1–4, 6–8].

Surface-coil images of five normal volunteers and one patient with a surgically proven intracanalicular acoustic neuroma were obtained. The subjects were studied in General Electric research MR scanners with superconducting 1.5 T magnets. A 54-cm-diam cylindrical coil routinely used for body imaging was used for radiofrequency transmission. A surface receiver coil having a diameter of 13.5 cm and tuned to the $^{1}H$ resonance frequency of 63.9 MHz was fixed near the petrous bones of the volunteers. Images were obtained in the axial (parallel to the canthomeatal line) or parasagittal plane. Technical factors included partial-saturation (PS) pulse sequences, a 350–400 msec repetition time (TR), 256 × 256 matrix, a 19 msec echo time (TE), 1–4 averages, 12.8 cm field of view corresponding to a pixel size of 0.5 × 0.5 mm, and 3- and 5-mm-thick sections.

Surface-coil images of the subjects and anatomic sections were correlated to identify specific cranial nerves in the internal auditory canals. The MR and CT images of the patient with an intracanalicular acoustic neuroma were correlated. The CT/T 8800 study was performed at Columbia Hospital in Milwaukee.

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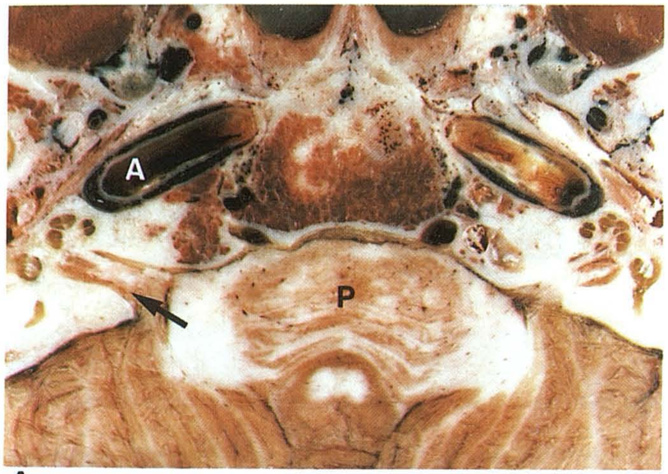


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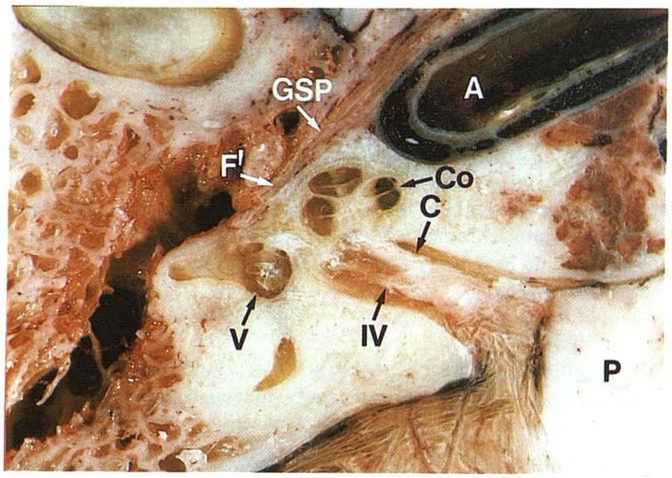


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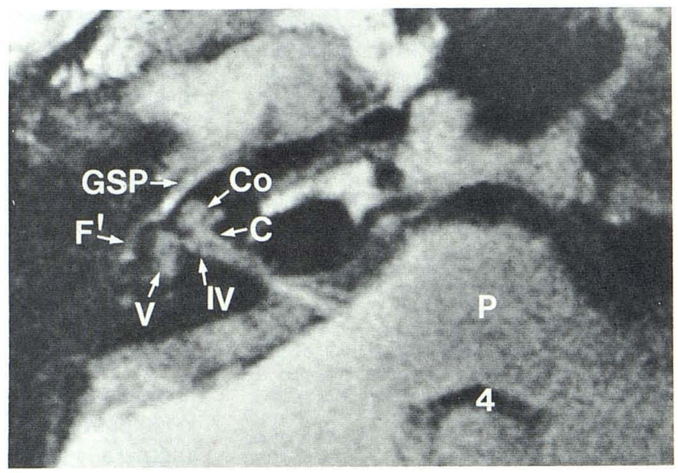



C

Fig. 1.—**A**, Axial anatomic section through inferior part of internal auditory canal (*arrow*). **B**, Higher magnification. **C**, Corresponding T1-weighted PS scan, 350 msec TR, 256 × 256 matrix, 4 averages, 3 mm thick. Cisternal and intracanalicular segments of inferior vestibular (IV) and cochlear (C) nerves, vestibule (V), cochlea (Co), horizontal segment (F′) of facial nerve, and greater superficial petrosal nerve (GSP) contrast to low-intensity signal from CSF and petrous bone. Cochlear nerve is anterior to inferior vestibular nerve. A = internal carotid artery; P = pons, 4 = fourth ventricle. (Reprinted from [9].)

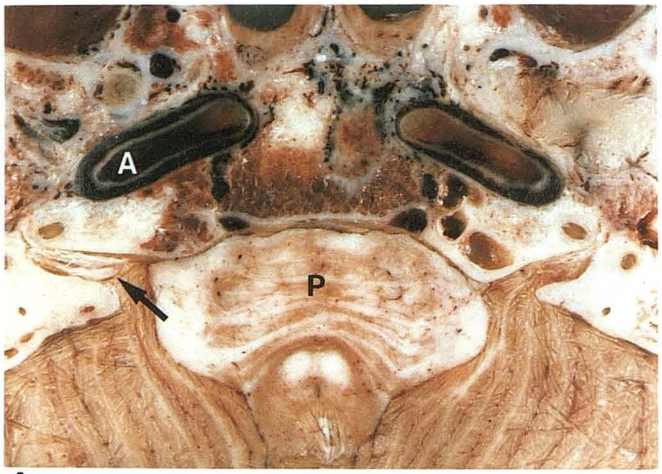
### Results and Discussion

The anatomic appearance of the internal auditory canal has been described in detail [6, 7]. The internal auditory canal contains the facial (VII) and vestibulocochlear (VIII) nerves, the latter having three branches. In axial cryomicrotomic sections parallel to the canthomeatal line and through the inferior part of the internal auditory canal, the inferior vestibular nerve and, anterior to it, the cochlear nerve have almost straight lateral courses extending from the brainstem to the vestibulocochlear apparatus (fig. 1). In an axial section through the superior part of the canal, the superior vestibular nerve and, more anterior to it, the facial nerve have similar courses (fig. 2). The facial nerve extends to the geniculate ganglion and turns posteriorly by the medial wall of the epitympanum. In sagittal cryomicrotomic sections through the internal auditory canal, these nerves are seen in cross section anterosuperiorly (facial nerve), posterosuperiorly (superior vestibular nerve), anteroinferiorly (cochlear nerve), and posteroinferiorly (inferior vestibular nerve) (fig. 3).

In axial PS surface-coil images of normal volunteers, structures are demonstrated consistently that correspond to individual nerves in the internal auditory canal and have a signal intensity intermediate betwen fat (high-intensity signal) and cortical bone and CSF (negligible signal) (figs. 1 and 2). In a section through the inferior part of the internal auditory canal, the inferior vestibular and cochlear nerves extend to the anterior margin of the vestibule and the posterior margin of the cochlea, respectively. In a section through the superior part of the internal auditory canal, the superior vestibular and facial nerves extend to the anterior margin of the vestibule and the sharply turning geniculate ganglion, respectively.

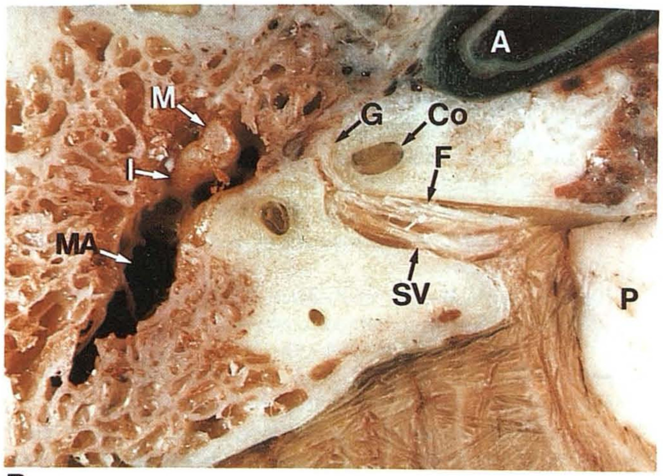
Sagittal PS surface-coil images commonly demonstrate structures that have the configuration of specific cranial nerves in the internal auditory canal (fig. 3). Each nerve has two signal intensities, possibly representing the nerve (central area of low signal intensity) and its sheath.

PS surface-coil images of the intracanalicular acoustic neuroma demonstrate a small mass that obscures the nerves in the right internal auditory canal and has uniform signal intensity greater than that of petrous bone (fig. 4). The CT study in the same case shows possible abnormal enhancing tissue in the right internal auditory canal without widening of the canal.




A

Fig. 2.—**A**, Axial anatomic section through superior part of internal auditory canal (*arrow*). **B**, Higher magnification. **C**, Corresponding PS scan, 350 msec TR, 256 × 256 matrix, 2 averages, 5 mm thick. Characteristic appearance of facial nerve (F) and its geniculate ganglion (G) distinguishes it from superior vestibular nerve (SV) coursing more posteriorly. A = internal carotid artery; P = pons; MA = mastoid antrum; I = incus; M = malleus; Co = cochlea; V = vestibule; 4 = fourth ventricle. (**A** and **B** reprinted from [9].)

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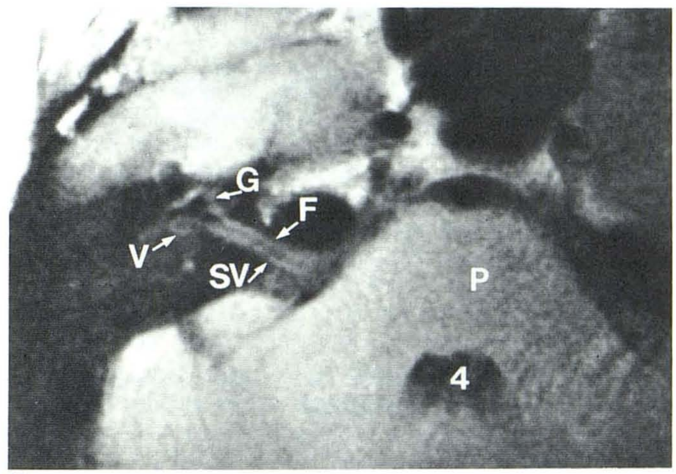


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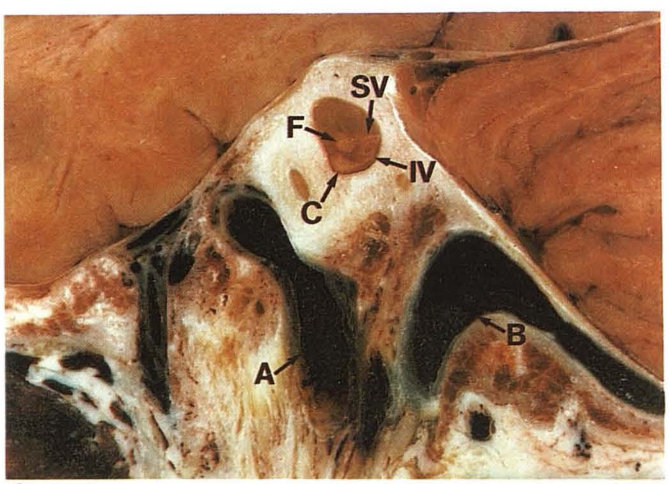


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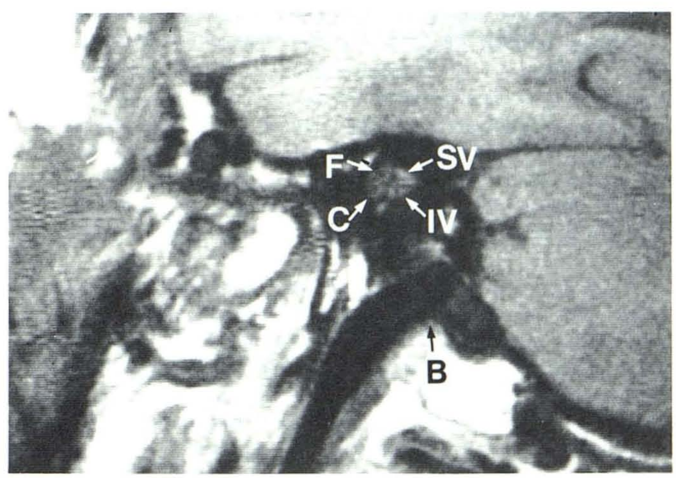


B

Fig. 3.—**A**, Parasagittal anatomic cross section of cranial nerves in internal auditory canal. **B**, PS image, 400 msec TR, 256 × 256 matrix, 1 average, 3 mm thick. Each nerve has two signal intensities, possibly representing nerve (central area of low signal intensity) and sheath. A = internal carotid artery; C = cochlear nerve; F = facial nerve; SV = superior vestibular nerve; IV = inferior vestibular nerve; B = jugular bulb.

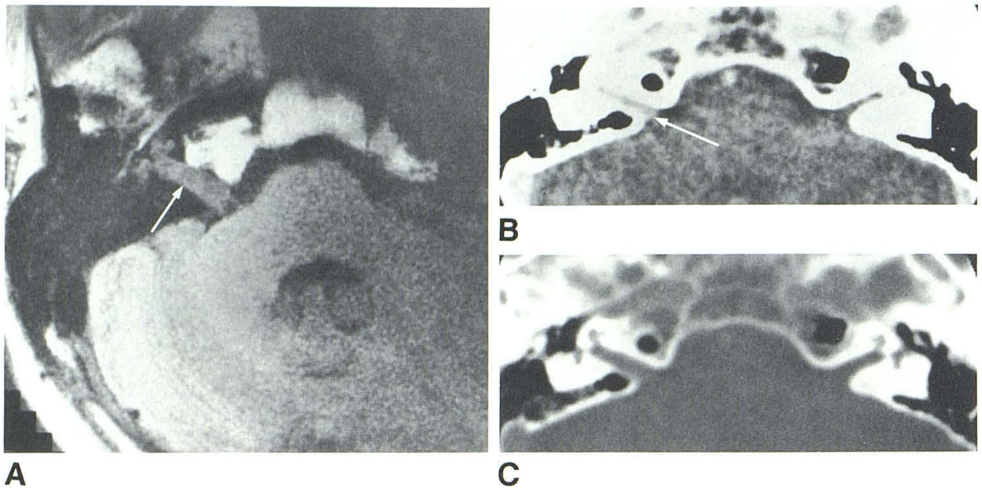


Fig. 4.—Right intracanalicular acoustic neuroma. **A**, Axial PS scan, 300 msec TR, 256 × 256 matrix, 4 averages, 3 mm thick. Tumor (*arrow*) obscures nerves in internal auditory canal. **B**, Contrast-enhanced CT scan. Possible abnormal enhancing tissue (*arrow*) in right canal but not in left. **C**, Contrast-enhanced CT scan at bone window setting. Internal auditory canals are normal. (**A** reprinted from [9].)

High-resolution surface-coil images consistently demonstrates individual nerves in the internal auditory canal. Early experience indicates that one sign of intracanalicular tumor is obscuring of these nerves. Further work is needed to determine the sensitivity of surface-coil imaging for detecting small acoustic neuromas and congenital anomalies causing neurosensory hearing loss.

## ACKNOWLEDGMENTS

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