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# Acoustic Neuromas: Evaluation by Magnetic Resonance Imaging

D. P. E. Kingsley<sup>1</sup>  
G. B. Brooks<sup>1</sup>  
A. W-L. Leung<sup>2</sup>  
M. A. Johnson<sup>2</sup>

Proton magnetic resonance imaging (MRI) examinations were performed in six patients with seven acoustic neuromas, and the results were compared with conventional tomography of the internal auditory canals, contrast-enhanced computed tomography (CT), and air CT cisternography. All tumors were identified with MRI. The three largest tumors (> 1 cm diameter) looked similar to the tumors seen on CT scans, although the extent of the tumor was better seen with MRI in two cases. The four small ( $\leq$  1 cm diameter) cerebellopontine angle and intracanalicular tumors were well seen with MRI, with appearances corresponding to those seen with air CT cisternography. No side effects were encountered with the MRI examinations. MRI is an accurate, noninvasive alternative to contrast-enhanced CT and air CT cisternography in the diagnosis of acoustic neuromas.

Acoustic neuromas are relatively common benign tumors that usually arise from the vestibular division of the eighth cranial nerve and characteristically occur in the cerebellopontine angle and internal auditory canal (IAC). Conventional radiologic diagnosis depends on the use of plain radiographs, conventional tomography, contrast-enhanced computed tomography (CT), air or gas CT cisternography, and vertebral angiography. Metrizamide CT cisternography is an alternative to air or gas CT cisternography but is associated with a higher incidence of side effects.

Abnormalities on plain radiographs and conventional tomograms depend on the development of bony changes that may be present when the tumor is small [1]. Contrast-enhanced CT is accurate in the detection of acoustic neuromas greater than 1 cm in size, but false negatives may occur in small or purely intracanalicular tumors [2, 3]. Therefore, air or gas CT cisternography is used for detecting small tumors and is very accurate [4], although false negatives may occur in the presence of arachnoid adhesions or very narrow IACs [5, 6]. Vertebral angiography is reserved for cases in which the surgeon needs to know the vascular supply of the tumor.

Early reports on low-resolution proton magnetic resonance imaging (MRI) have described acoustic neuroma appearances similar to those seen on contrast-enhanced CT [7-9], although intracanalicular extension of a small acoustic neuroma has also been described [10]. With recent improvements in the quality of MR images, including the use of a  $256 \times 256$  reconstruction matrix, it is now possible to routinely image the normal IAC containing the seventh and eighth cranial nerves. This provides the anatomic basis for the demonstration of small acoustic neuromas and gives MRI as good a potential for diagnosis as contrast-enhanced CT and air CT cisternography. We compared the results of conventional tomography, contrast-enhanced CT, air CT cisternography, and MRI of the IAC in six patients with acoustic neuromas.

## Subjects and Methods

Six patients (four men and two women) with clinical diagnoses of acoustic neuromas were

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M. A. Johnson is an Alberta Heritage Scholar.

<sup>1</sup> Departments of Radiology and Otolaryngology, London Hospital, Whitechapel, London E1 1BB, England.

<sup>2</sup> Department of Diagnostic Radiology, Royal Postgraduate Medical School, Hammersmith Hospital, DuCane Rd., London W12 0HS, England. Address reprint requests to M. A. Johnson.

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TABLE 1: Conventional Tomography, Contrast-Enhanced CT, Air CT Cisternography, and MRI of the Internal Auditory Canal for Imaging Acoustic Neuromas: Comparison of Findings

Case No. (age, gender)	Clinical Features (Duration)	Conventional Tomography	Contrast-Enhanced CT	Air CT Cisternography	MRI
1 (38, M) . . . . .	Otalgia, tinnitus, deafness (2 years); sensori-neural deafness	Marked enlargement of canal and porus	Low attenuation, nonenhancing mass displacing fourth ventricle	Large mass in cerebellopontine angle extending anterior to porus	4 cm intra- and extracanalicular tumor
2 (61, F) . . . . .	Vertigo, tinnitus, deafness (3 years); right sensorineural deafness	Widened right IAC	1.5 cm contrast-enhancing cerebellopontine angle mass on right	1.5 cm mass in right cerebellopontine angle	1.5 cm bilobular mass in angle and canal
3 (33, F) . . . . .	Deafness, vertigo (5 years); left sensorineural deafness	Left flask-shaped canal, normal porus	Normal	Tumor just projecting into left cerebellopontine angle	0.8 cm tumor in left IAC
4 (49, M) . . . . .	Deafness (long history); right sensorineural deafness	Funneling of right IAC	...	1 cm mass in right cerebellopontine angle	1 cm mass in right cerebellopontine angle with extension into IAC
5 (48, M) . . . . .	Left-sided deafness, tinnitus (2 years)	Funneling of left IAC	1 cm contrast-enhancing cerebellopontine angle tumor	...	1 cm intra- and extracanalicular tumor
6 (44, M) . . . . .	Progressive deafness on left and slight deafness on right (20 years); neurofibromatosis	Funneling of both IACs, right greater than left	1.5 cm contrast-enhancing cerebellopontine angle mass on right; normal left side	...	Bilateral cerebellopontine angle and IAC tumors; right 1.5 cm and left 1 cm

Note.—IAC = internal auditory canal.

TABLE 2: Pulse Sequences Used in MRI of the Internal Auditory Canal in Patients with Acoustic Neuromas

Pulse Sequence	Interval (msec)		
	TR	TI	TE
Inversion-recovery (IR): IR 1500/500/44 . . . . .	1500	500	44
Spin-echo (SE): SE 540/40 . . . . .	540	...	40
SE 544/44 . . . . .	544	...	44
SE 1580/80 . . . . .	1580	...	80

selected (table 1). These patients had conventional diagnostic studies consisting of IAC tomography and CT (with and without 50 ml of Conray 420 for enhancement) using either an Elscint Exel 905 or EMI CT 1010 CT scanner. Air CT cisternography was performed using the same instrument in patients with suspected small or purely intracanalicular tumors.

MRI was performed on a cryogenic magnet-based imaging system operating at 0.15 T; its use in four patients has been described [11], as has a similar machine operating at 0.5 T in two cases. Permission was obtained from the Royal Postgraduate Medical School, and MRI was performed in accordance with guidelines provided by the National Radiological Protection Board [12]. Several pulse sequences were used, and these are described in table 2 using American College of Radiology nomenclature [13].

The patients' clinical histories and subsequent surgical results in four cases were reviewed. One patient initially referred into this study with a slightly widened porus had a normal MRI examination followed by normal air CT cisternography and was not considered further.

## Results

No adverse effects were encountered from the MRI examination. The results of clinical examination, conventional

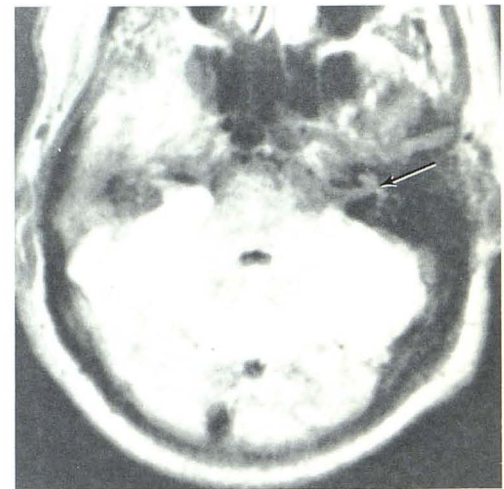


Fig. 1.—SE 1580/80. Normal seventh and eighth cranial nerves (arrows) in intracanalicular course.

tomography, contrast-enhanced CT, air CT cisternography, and MRI are summarized in table 1. Acoustic neuromas were surgically removed in four cases.

Plain skull radiographs and tomograms showed generalized enlargement of the IAC in two cases, a flask-shaped IAC in one, and funneling in the other. CT was performed in five of six cases and was positive in four of six tumors. Air CT cisternography was undertaken in four of six patients and was positive in each.

MRI demonstrated a normal IAC on the uninvolved side in five of the six cases (fig. 1) (the exception being bilateral tumors in case 6). The normal appearances were seen well



Fig. 2.—Case 1, 4 cm acoustic neuroma. **A** and **B**, Contrast-enhanced CT scans after injection of 50 ml of Conray 420. **A**, Tumor has low attenuation. **B**, Bony change seen well. IR 1500/500/44 (**C**) and SE 1580/80 (**D**) scans better show full extent of tumor.

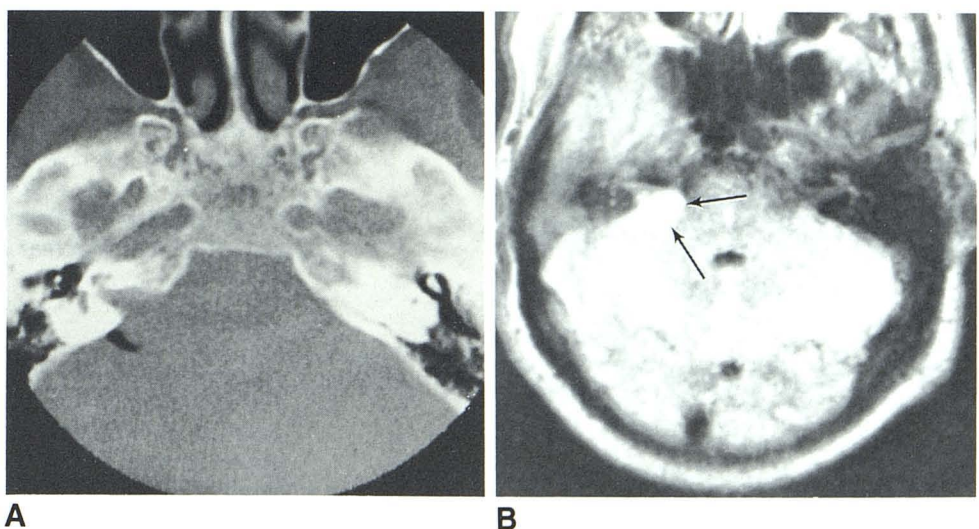
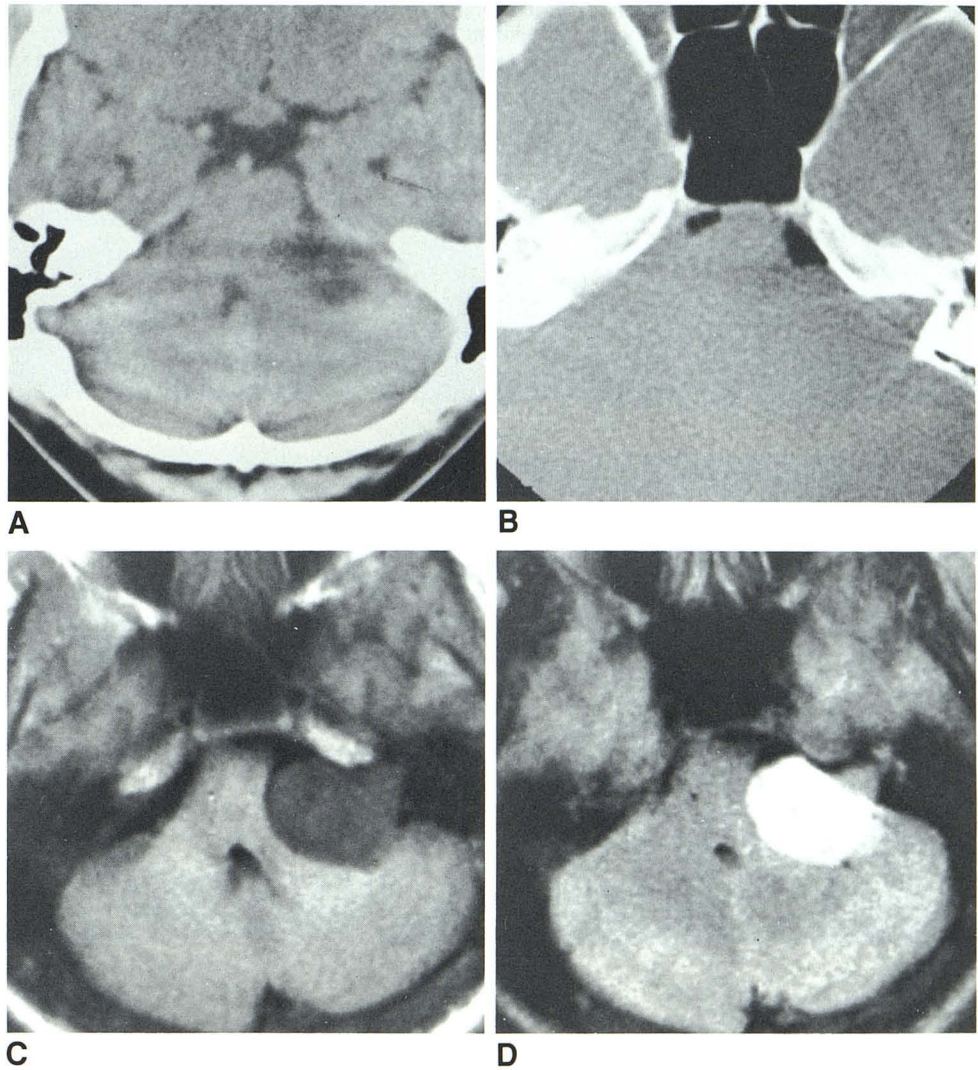


Fig. 3.—Case 2, 1.5 cm acoustic neuroma. Air CT cisternogram (**A**) and SE 1580/80 scan (**B**). Tumor (arrows) mainly in cerebellopontine angle, but intracanalicular extension is apparent.

because of the lower signal received from the surrounding dense petrous bone.

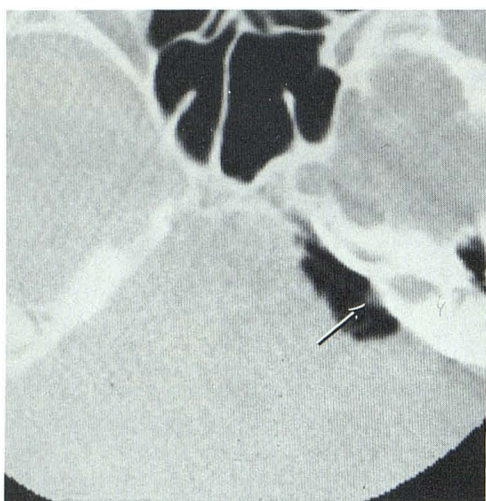
The intracanalicular and cerebellopontine angle components of all seven tumors were demonstrated well with MRI.

These included large tumors in which the medial extent of the tumor was demonstrated better than it had been with contrast-enhanced CT (fig. 2). In other cases the tumor was smaller and largely in the cerebellopontine angle, with an

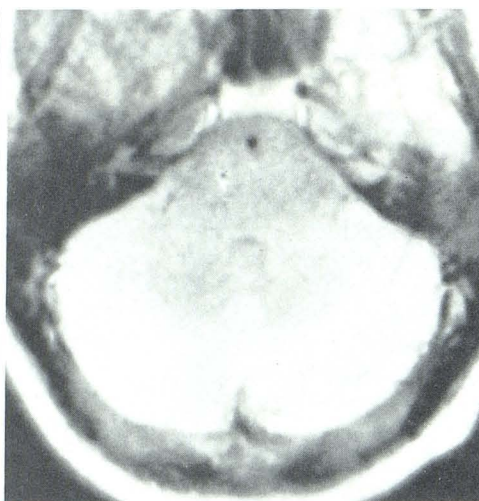




A



B



C

Fig. 4.—Case 3, 0.8 cm acoustic neuroma. **A**, Conventional tomogram. Expansion of IAC. **B**, Air CT cisternogram. Small component of tumor in left cerebellopontine angle is seen. **C**, SE 1580/80 scan. Tumor is seen well.

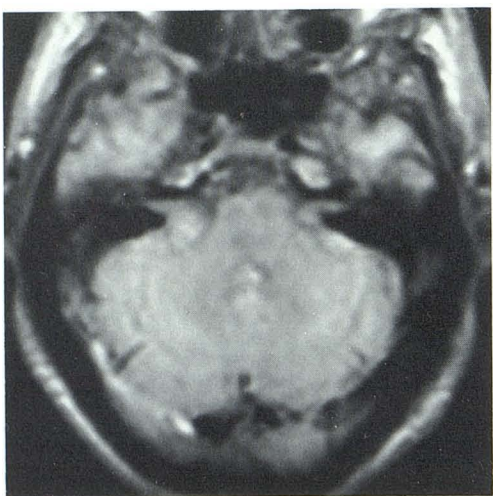


Fig. 5.—Case 6, bilateral acoustic neuromas. SE 540/40 scan. Both tumors seen well.

extension into the adjacent IAC giving it a funnel-shaped appearance (fig. 3). A small, largely intracanalicular tumor was also demonstrated (fig. 4).

Bilateral tumors were seen in case 6, although CT only demonstrated a single tumor (fig. 5). This patient's hearing was better on the side with the larger tumor, and initial management was conservative. Skin biopsy confirmed a diagnosis of neurofibromatosis.

### Discussion

In our small series of cases the information provided by both contrast-enhanced CT and air CT cisternography was provided by MRI also. In addition the extent of the three largest tumors was accurately demonstrated by MRI. Although CT usually displays dense, homogeneous enhancement giving excellent demonstration of large acoustic neuromas, less well defined areas of low attenuation may be seen also. Small tumors were also positive, rather than appearing

as a failure to fill the IAC with air. Therefore, MRI might have an important role in the diagnosis of acoustic neuromas, since it is totally noninvasive and does not have the complications associated with contrast injection or lumbar puncture. The exclusion of acoustic neuromas in patients with sensorineural deafness can be inferred using MRI from demonstration of the normal IAC, and air CT cisternography is not needed.

Bony changes are better shown with conventional tomography than with MRI, although these changes can be inferred to some extent from the MRI appearances. MRI does not provide the vessel detail available with vertebral angiography, so that both these investigations may still be required in particular cases.

Acoustic neuromas generally display a moderate increase in T1 and T2, giving a darker appearance than brain with the inversion-recovery sequence used in our study and a lighter appearance with the SE 1580/80 sequence, thus providing contrast at the margin between tumor and brain.

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