AJNR

Gadolinium-enhanced MR of the postoperative internal auditory canal following acoustic neuroma resection via the middle fossa approach.

D P Mueller, B J Gantz and K D Dolan

AJNR Am J Neuroradiol 1992, 13 (1) 197-200
http://www.ajnr.org/content/13/1/197

Gadolinium-Enhanced MR of the Postoperative Internal Auditory Canal Following Acoustic Neuroma Resection via the Middle Fossa Approach

Donald P. Mueller,[1] Bruce J. Gantz,[2] and Kenneth D. Dolan[1]

Purpose: To evaluate the ability of gadolinium-enhanced MR in detecting recurrent tumor in patients whose acoustic neuromas were surgically removed via the middle cranial fossa approach. **Patients and Methods:** Postoperative gadolinium-enhanced exams of 13 of 44 patients who underwent excision of acoustic neuromas via the middle cranial fossa approach were reviewed. **Results:** Postoperative enhancement was seen in 12 of the 13 patients; two patients underwent serial exams without significant change. On the basis of a single exam, we were unable to conclusively differentiate postoperative enhancement from residual or recurrent tumor. **Conclusions:** A single exam is of limited value. Serial studies are recommended to identify changes that would indicate tumor growth. A proposed MR follow-up schedule is an initial baseline exam within 2 months of surgery and a repeat exam during the second postoperative year.

Index terms: Nerves, vestibulocochlear (VIII); Neuroma; Magnetic resonance, postoperative; Magnetic resonance, contrast enhancement; Contrast media, paramagnetic

AJNR 13:197–200, January/February 1992

Small acoustic neuromas may be resected through the middle cranial fossa. This technique is useful for the preservation of both hearing and facial nerve function (1). However, residual or recurrent is always of concern (2). This study examines the ability of postoperative gadolinium-enhanced magnetic resonance (MR) to detect recurrent tumor in patients having acoustic neuromas removed via the middle fossa approach.

Materials and Methods

Forty-four patients at our institution underwent acoustic neuroma excision through the middle cranial fossa approach from 1984 through 1990. We reviewed retrospectively the radiographic records of these patients. Patients without postoperative follow-up examinations or whose examinations were not contrast-enhanced were excluded from the study. There were thirteen patients with postoperative gadolinium-enhanced MR examinations. Eleven studies were performed as routine follow-up examinations. One study was performed for evaluation of coexisting abnormalities of the nonoperated eighth nerve and fifth nerve. One examination was requested by a non-otolaryngologist. At the time of the study the otolaryngologist did not suspect tumor recurrence. The earliest examination was 7 months following surgery. The latest examination was 68 months post surgery. The timing of scans relative to surgery is itemized in Table 1.

Two patients received multiple examinations. These serial examinations were obtained because of enhancement identified on the initial study. Tumor recurrence was not suspected clinically. The first patient obtained scans at 7, 20, and 25 months post surgery; the second obtained scans at 48, 56 and 68 months post surgery.

Nine examinations were performed on a 0.5 T Vista unit (Picker, Highland Heights, OH). T1-weighted (316-500/20/4 (TR/TE/NEX)) images of the internal auditory canal with 4- to 5-mm slice thickness and T2-weighted (2000/100/2), 10-mm thick, axial images of the whole brain were obtained. Eight examinations were performed on a 1.5 T Signa unit (General Electric, Milwaukee, WI). T1-weighted

TABLE 1: Timing of scans relative to surgery

Time after Surgery (mo)	Examinations
0–12	1
12–24	4
25–36	6
37–48	4
>48	2

Received March 11, 1991; accepted and revision requested May 20; revision received July 19.

[1] Department of Radiology, University of Iowa Hospitals and Clinics, Iowa City, IA 52242. Address reprint requests to D.P. Mueller.

[2] Department of Otolaryngology, University of Iowa School of Medicine, Iowa City, IA 52242.

AJNR 13:197–200, Jan/Feb 1992 0195-6108/92/1301-0197

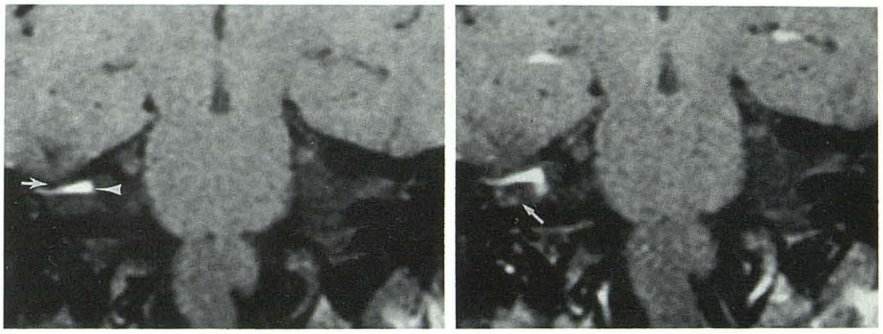


Fig. 1. *A*, Postoperative coronal T1-weighted MR image of the internal auditory canals without gadolinium. The exam demonstrates a narrowed space between the temporal lobe and the internal auditory canal (*arrow*) and increased signal about the superior margin of the internal auditory canal consistent with adipose tissue or bone marrow (*arrowhead*).

B, Coronal T1-weighted MR image at the internal auditory canals following gadolinium administration. Irregular wall enhancement is seen (*arrow*).

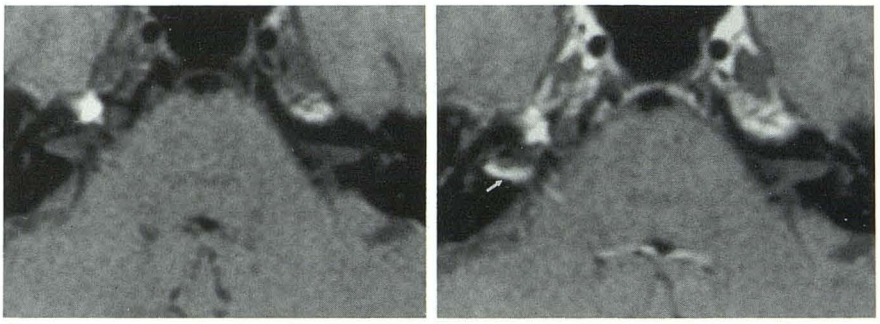


Fig. 2. *A*, Postoperative axial T1-weighted MR image of the internal auditory canals without gadolinium. Signal from the right internal auditory canal is unremarkable.

B, Linear enhancement within the IAC is identified following gadolinium administration (*arrow*).

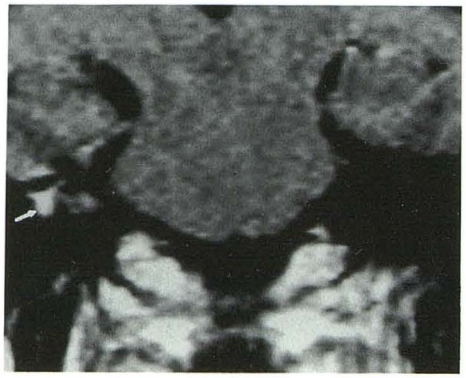


Fig. 3. Postoperative coronal T1-weighted MR image following gadolinium administration. Globular enhancement is seen within the internal auditory canal (*arrow*).

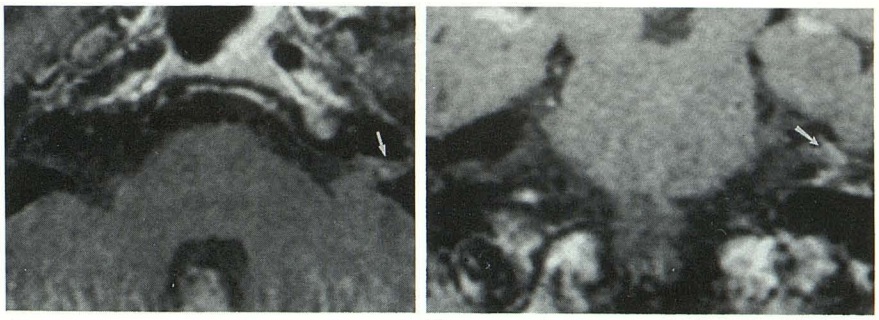
(550-600/25/2), 3-mm thick images of the internal auditory canal and T2-weighted (2100-2300/90/1), 5-mm thick, axial images, of the whole brain were obtained. A 10% slice gap was used on T1 sequences and a 50% slice gap was used on T2 sequences in the examinations performed at the higher field strength. All T1-weighted studies were performed in the axial and coronal planes before and after intravenous administration of 0.1 mmol/kg gadopentetate dimeglumine.

Results

Intraoperative bone removal narrowed the distance between the internal auditory canal and the adjacent temporal lobe (Fig. 1A). The cerebellopontine angle cisterns were normal. Twelve of 13 patients demonstrated enhancement at the operative site. The patterns varied and included linear (3 cases) (Figs. 2A and 2B), globular (6 cases) (Fig. 3), and irregular wall (3 cases) (Fig. 1B) enhancement. Enhancement was seen on the earliest scan obtained (7 months) and the latest scan (68 months). Enhancement about the superior margin of the internal auditory canal was seen in 8 of 13 patients (Figs. 4A and 4B). One case demonstrated increased signal on TIW images about the superior margin of the internal auditory canal both before and after gadolinium administration (Fig. 1). Serial examinations were performed in two patients. No change in enhancement pattern was identified over the intervals studied.

Discussion

The middle fossa approach is performed via a craniotomy in the squamous portion of the temporal bone. Following middle cranial fossa dura elevation, bone is removed from the arcuate eminence to identify the superior semicircular canal (1) (Fig. 5). Bone removal then continues anteriorly to expose the internal auditory canal. After tumor removal, the temporal bone surgical defect is packed with temporalis muscle and fascia. This is then covered with a small piece of bone. The temporalis muscle used to close the internal auditory canal defect represents a potential source



A B

Fig. 4. *A,* Postoperative axial T1-weighted MR following gadolinium administration. Enhancing focus appears to fill the internal auditory canal (*arrow*).

B, Coronal T1-weighted MR image following gadolinium administration. The irregular nature of the enhancement is seen. Much of the enhancement is seen above the plane of the internal auditory canal in the expected location of packing material (*arrow*).

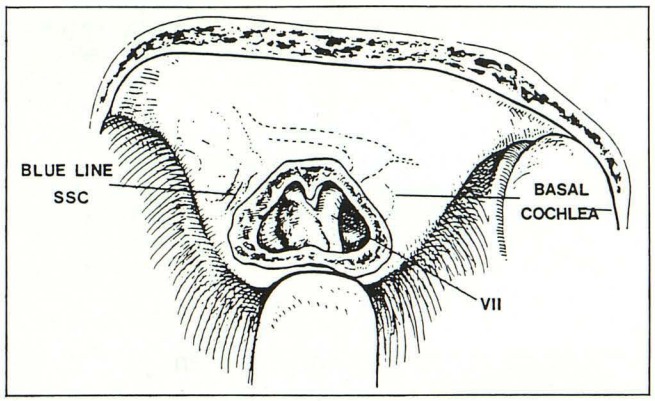


Fig. 5. The middle cranial fossa exposure for removal of acoustic tumors. The temporal lobe is retracted. The superior semicircular canal (*SSC*) is identified. The internal auditory canal has been unroofed, exposing tumor and the seventh (*VII*) nerve. (Reproduced by permission, Gantz et al (7)).

of enhancement that may not be present following tumor resection by the translabyrinthine or suboccipital approach.

This approach is useful for tumors extending less than 1.5 cm outside the porous acousticus. Goals of the surgery include preservation of hearing and facial nerve function. Using this technique, residual auditory function has been identified in 52% of patients following tumor removal (1). The possibility of leaving residual tumor when hearing conservation surgery is performed has been raised. Histologic studies performed by Neely (2) have questioned the ability to totally remove tumor and preserve hearing. Careful postoperative follow-up is therefore indicated. To our knowledge, the role of gadolinium-enhanced MR imaging in the postoperative evaluation of these patients has not been evaluated. Our study indicates that enhancement about the internal auditory canal is common and to be expected. Enhancement was identified on both the earliest (7 months) and latest (68 months) studies in our series. Two patients underwent multiple examinations. The enhancement pattern did not vary with time.

Postoperative enhancement raises concern for residual or recurrent tumor. Other causes must also be considered. A portion of the enhancement may relate to the temporalis muscle and/or fascia used to seal the bony defect in the internal auditory canal. In particular, the enhancement identified near the bony defect may be caused by packing material. The globular pattern of enhancement could be caused by muscle or fascia protruding into the internal auditory canal. Beatty (3), in his study of recurrent acoustic neuromas, also identified adhesions, cysts, and scar at the time of reoperation. Elster (4) and Burke (5) have identified dural enhancement following craniotomy. Dural enhancement has been identified as early as 1 month and as late as 40 years following craniotomy (4). Millen (6) noted gadolinium enhancement within the facial nerve 7 years following facial nerve graft for a neuroma. Postoperative adhesions, residual tumor, enhancement of temporalis muscle and fascia, and trauma to nerve must all, therefore, be considered in the differential diagnosis of postoperative enhancement.

In one case (Fig. 1), an area of increased signal on TIW images was present above the internal auditory canal both before and after the administration of gadolinium. This suggests the presence of fat or blood. Although fat is not used as a primary packing material, it may accompany the temporalis muscle or fascia. This is felt to represent the most probable cause for the signal in this case. Alternatively, marrow within bone used to cap the surgical defect could give rise to increased signal. A third possible cause for the signal is residual blood in the operative site.

Development of an MR protocol for postoperative evaluation of acoustic neuromas involves many considerations. Tumor recurrence is rare. Gantz (7) identified recurrence in only one of 43

patients undergoing tumor resection via the middle fossa approach. The rate of tumor growth is unpredictable. Valvassori (8) analyzed 35 cases in which acoustic neuromas were not resected and in which follow-up examinations were performed. The length of follow-up ranged from 8 months to 12 years. Tumor growth was identified in only 20 of 35 (57%) of cases. However, tumor growth was identified in six of nine cases in which follow-up was less than 1 year. This indicates that growth can be observed in early follow-up studies. The frequent appearance of enhancement following gadolinium administration decreases the ability to identify tumor recurrence. Although patterns such as linear or irregular wall enhancement are less suspicious than globular enhancement, it is difficult to totally exclude residual or recurrent tumor based on a single exam.

Consideration, therefore, must be given to the rarity of tumor recurrence and the desirability of multiple examinations to evaluate change in enhancement pattern. Based on the above factors the current recommendation at our institution is an early follow-up examination within 2 months of surgery to serve as a baseline study. A follow-up examination is performed 2 years postoperatively. If any change suggestive of recurrence has occurred, serial follow-up examinations are performed. A change in the patient's clinical status that suggests recurrence would also prompt additional MR evaluation. It is recommended that pre- and post-gadolinium images be obtained in both the axial and the coronal planes.

References

1. Gantz BJ. Acoustic tumor excision using middle cranial fossa approach: indications and results. In: Fisch U, Valvanis A, Yasargil MG, eds. *Neurological surgery of the ear and skull base.* Amsterdam: Kugler & Ghedin, 1989:169–174
2. Neely JG. Hearing conservation surgery for acoustic tumors: a clinical-pathological correlative study. *Am J Otol* 1985;6(Suppl):143–146
3. Beatty CW, Ebersol MJ, Harner SG. Residual and recurrent acoustic neuromas. *Laryngoscope* 1987;97:1168–1171
4. Elster AD, DiPersio DA. Cranial postoperative site: assessment with contrast-enhanced MR imaging. *Radiology* 1990;174:93–98
5. Burke JW, Podrask AE, Bradley WG. Meninges: benign postoperative enhancement on MR images. *Radiology* 1990;174:99–102
6. Millen SJ, Daniels D, Meyer G. Gadolinium-enhanced magnetic resonance imaging in facial nerve lesions. *Otolaryngol Head Neck Surg* 1990;102:26–33
7. Gantz BJ, Parnes LS, Harker LA, McCabe BF. Middle carnial fossa acoustic neuroma excision: results and complications. *Ann Otol Rhinol Laryngol* 1986;95:454–459
8. Valvassori GE, Guzman M. Growth rate of acoustic neuromas. *Am J Otol* 1989;10:174–176