Postoperative Magnetic Resonance Imaging after Acoustic Neuroma Surgery: Influence of Packing Materials in the Drilled Internal Auditory Canal on Assessment of Residual Tumor

Hiromichi UMEZU and Yojiro SEKI

Department of Neurosurgery, Toranomon Hospital, Tokyo

Abstract

Serial magnetic resonance (MR) images taken after acoustic neuroma surgery were analyzed to evaluate the pattern and timing of postoperative contrast enhancement in 22 patients who underwent acoustic neuroma removal via the suboccipital transmeatal approach. The opened internal auditory canal (IAC) was covered with a muscle piece in nine patients and with fibrin glue in 13. A total of 56 MR imaging examinations were obtained between days 1 and 930 after surgery. MR imaging showed linear enhancement at the IAC within the first 2 days after surgery, and revealed nodular enhancement on day 3 or later in patients with a muscle piece. MR imaging tended to show linear enhancement at the IAC, irrespective of the timing of the examination in the patients with fibrin glue. Postoperative MR imaging on day 3 or later showed the incidence of nodular enhancement in patients with muscle was significantly higher than in patients with fibrin glue. The results illustrate the difficulty in differentiating nodular enhancement of a muscle piece from tumor by a single postoperative MR imaging study. Therefore, fibrin glue is generally advocated as a packing material of the IAC because it rarely shows masslike enhancement on postoperative MR imaging. When a muscle piece is used in patients at high risk for postoperative cerebrospinal fluid leaks, MR imaging should be obtained within the first 2 days after surgery, since benign enhancement of muscle will not occur and obscure the precise extent of tumor resection.

Key words: acoustic neuroma, internal auditory canal, magnetic resonance imaging, suboccipital approach

Introduction

The suboccipital transmeatal approach is widely used for the surgical resection of acoustic neuromas because it allows excellent exposure of the tumor within the cerebellopontine angle cistern.\(^{1,4,9,12,13,15}\) However, residual tumor may persist in the lateral part of the internal auditory canal (IAC) since this approach to the canal is medial to lateral. Drilling of the posterior surface of the petrous bone is usually limited by the extent of tumor extension toward the fundus in the IAC, the extent of widening and shortening of the IAC, the location of the inner ear apparatus or jugular bulb,\(^{6}\) and preoperative hearing function. Therefore, intraoperative detection of the presence of residual tumor in the lateral end of the IAC is more difficult. Once the tumor has been removed, including any portion within the IAC, the drilled posterior wall must be covered with material such as bone wax, fibrin glue, fat, or muscle to prevent future leakage of cerebrospinal fluid. Bone wax and fibrin glue are easily available and less reactive, but bone wax is difficult to spread in a deep and narrow place, and fibrin glue is absorbed in a short period, so the long-term prevention of cerebrospinal fluid leaks remains uncertain. Fat is less reactive and shows little contrast enhancement on magnetic resonance (MR) imaging, but another skin incision on the abdomen or thigh is needed to harvest the material and the high signal intensity of fat obscures subtle enhancement in the surgical bed on postoperative MR imaging. A muscle piece can be obtained within the same operative field, but often shows globular contrast enhancement which is
difficult to distinguish from residual or recurrent tumor on postoperative MR imaging.\(^4,8,15\) Furthermore, scarring in the IAC secondary to packing with a muscle graft is considered to be one of the most likely causes of delayed hearing loss.\(^4,11,14\) Therefore, the presence of residual tumor is not always possible to ascertain either by careful inspection during surgery or by meticulous assessment of postoperative MR imaging.

In this study, serial MR imaging was performed in patients who underwent acoustic neuroma surgery and in patients who underwent vestibular neurectomy for benign disease to determine the optimal timing of postoperative MR imaging for evaluating the extent of tumor resection at surgery, and to investigate the most suitable method of shielding the drilled posterior wall of the IAC to minimize interpretative difficulties caused by contrast enhancement on postoperative MR imaging.

**Materials and Methods**

Twenty-two consecutive patients, 10 females and 12 males (mean age 50.6 years), underwent microsurgical total removal of a unilateral acoustic neuroma at our institution between April 1993 and September 1995. All operations were performed by a single neurosurgeon (Y.S.) using the suboccipital, transmeatal approach in the lateral position. After drilling the posterior wall of the IAC, the intracanalicular portion of the tumor was removed as thoroughly as possible. The drilled posterior wall was then covered with muscle in nine patients and with fibrin glue in 13. Postoperative MR imaging was carried out using 1.5-Tesla superconductive MR imaging systems. Axial and coronal T\(_1\)-weighted (repetition time/echo time 400 msec/14 msec) images were obtained before and after intravenous administration of gadolinium-diethylenetriaminepenta-acetic acid (Gd-DTPA). The 22 patients underwent a total of 56 MR imaging studies. The imaging appearance of the IAC was classified as one of four enhancement patterns (Fig. 1): Type 1, no contrast enhancement within the IAC; Type 2, peripheral linear enhancement of the IAC; Type 3, nodular enhancement almost completely filling the IAC; and Type 4, enhanced mass in the IAC protruding into the cerebellopontine angle cistern suggestive of tumor recurrence. The postoperative follow-up period ranged from 139 to 930 days (mean 560 days). No patients developed cerebrospinal fluid leakage during the follow-up period.

Postoperative MR images of seven patients who had undergone vestibular neurectomy for intractable vertigo due to nonneoplastic diseases were examined as controls. Both the superior and the inferior vestibular nerves were sectioned selectively near the fundus of the IAC after drilling the posterior wall through the paramedian suboccipital craniectomy.\(^10\) Following vestibular neurectomy, the posterior wall was covered by muscle in four patients and by fibrin glue in three. Postoperative MR imaging was performed 7 to 408 days (mean 186.3 days) after surgery and the findings were divided into one of the four types of the above classification. The results were analyzed for statistical significance by Fisher's exact probability test.

**Results**

No patients demonstrated a Type 4 enhancement pattern, which was suggestive of tumor recurrence.
I. Initial postoperative MR imaging in patients with acoustic neuroma

All initial postoperative MR images in the nine patients with muscle used to cover the posterior wall of the IAC showed linear enhancement when examined within the first 2 days following surgery and nodular enhancement when on day 3 or later. Initial MR images after surgery in 11 of the 13 patients with fibrin glue used to pack the IAC demonstrated linear enhancement in the IAC. The other two patients underwent MR imaging 15 and 25 days following surgery and showed nodular enhancement (Table 1). When postoperative MR imaging studies were obtained on day 3 or later, the incidence of nodular enhancement in patients with muscle repair was significantly higher than in patients with fibrin glue (p < 0.01).

II. Serial postoperative MR imaging in patients with acoustic neuroma

Fifteen patients underwent postoperative MR imaging studies twice or more. The pattern of enhancement at the IAC changed during the follow-up period in five of seven patients with muscle repair and in four of eight patients with fibrin glue (Table 2). Three patients with muscle repair underwent initial postoperative MR imaging within 2 days after surgery and demonstrated linear enhancement, but repeat MR imaging performed between days 7 and 9 after surgery showed linear enhancement in two patients and nodular enhancement in one. Follow-up MR imaging between days 127 and 172 after surgery revealed linear enhancement in one patient and nodular enhancement in two. Three patients with muscle repair had nodular enhancement at the initial MR imaging, but linear enhancement at the follow-up MR imaging performed between days 196 and 304 after surgery. Three patients with fibrin glue underwent the initial postoperative MR imaging study within the first 2 weeks after surgery and showed linear enhancement. The MR imaging findings in these patients remained unchanged during the follow-up period ranging from 320 to 694 days postoperatively.

III. Postoperative MR imaging findings in patients with non-neoplastic diseases

Postoperative MR imaging examinations were carried out between 7 and 266 days (mean 131.8 days) after vestibular neurectomy in four patients with muscle repair of the posterior wall of the IAC and between 15 and 408 days (mean 259 days) in three patients who received fibrin glue repair. MR imaging showed nodular enhancement at the IAC in three patients and linear enhancement in one of the four patients with muscle repair. Linear enhancement was seen in two patients and no enhancement in one of the three patients with fibrin glue. Even in patients with non-neoplastic diseases, MR imaging after surgery frequently demonstrated nodular enhancement within the IAC when muscle was used to cover the drilled petrous bone.

Table 1 Timing of postoperative magnetic resonance imaging and pattern of enhancement in the internal auditory canal (IAC)

<table>
<thead>
<tr>
<th>Time after surgery (day)</th>
<th>Type 1*</th>
<th>Type 2*</th>
<th>Type 3*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Muscle</td>
<td>Fibrin</td>
<td>Muscle</td>
</tr>
<tr>
<td>≤2</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>3–14</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15–30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>≥31</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Pattern of enhancement: Type 1, no enhancement of IAC; Type 2, linear enhancement of IAC; Type 3, nodular enhancement of IAC.

Table 2 Change of enhancement pattern in the internal auditory canal

<table>
<thead>
<tr>
<th>Type 3→2*</th>
<th>Type 2→1*</th>
<th>Type 2→3*</th>
<th>No change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muscle</td>
<td>3</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Fibrin</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

*See Table 1 for definitions.

Neurol Med Chir (Tokyo) 39, February, 1999
IV. Representative examples

Case 1: A 53-year-old male in otherwise excellent health presented with a 3-year history of hearing loss and tinnitus on the right side. MR imaging with Gd revealed a small acoustic neuroma (Fig. 2 upper). The tumor was removed totally via a suboccipital, transmeatal approach and the drilled posterior wall of the IAC was covered with a muscle piece. MR imaging obtained on days 1 and 7 after surgery demonstrated linear enhancement along the anterior wall of the internal auditory canal (arrow).

Fig. 2 Case 1, a 53-year-old male with an acoustic neuroma. Preoperative T₁-weighted magnetic resonance (MR) image with gadolinium (Gd) (upper) showing a small acoustic neuroma. T₁-weighted MR images (middle) and with Gd (lower) obtained on day 1 after surgery using a muscle piece demonstrating linear enhancement along the anterior wall of the internal auditory canal (arrow).

Case 2: A 52-year-old female presented with a 6-month history of unilateral hearing loss and sense of pressure in the right ear. MR imaging revealed a medial type of small acoustic neuroma, i.e. a tumor with an empty space at the lateral end of the IAC (Fig. 4 upper, middle). Complete removal of the tumor was accomplished through a suboccipital, transmeatal approach. Fibrin glue was used to shield the drilled petrous bone, because preoperative bone computed tomography (CT) showed that the mastoid air cells did not extend into the posterior wall of the IAC. Postoperative MR imaging on day 9 showed linear enhancement of the inner surface of the IAC including the lateral end where no tumor had been present preoperatively (Fig. 4 lower).

Case 3: A 59-year-old male underwent left vestibular neurectomy via a suboccipital, transmeatal approach for relief of intractable vertigo due to Ménière's disease on the left, and the drilled petrous bone was covered with a muscle piece. MR imaging 149 days after surgery demonstrated linear enhancement of the dura within the IAC and nodular enhancement of the muscle at the drilled petrous bone (Fig. 5).
Fig. 4 Case 2, a 52-year-old female with an acoustic neuroma. Preoperative coronal (upper) and axial (middle) T₁-weighted magnetic resonance (MR) images with gadolinium (Gd) showing a small acoustic neuroma and an empty space at the fundus of the internal auditory canal (IAC) (arrow). Coronal T₁-weighted MR image with Gd on day 9 after surgery using fibrin glue (lower) demonstrating linear enhancement outlining the IAC including the lateral end (arrowheads) where no tumor was present preoperatively.

Fig. 5 Case 3, a 59-year-old male with Ménière’s disease who underwent vestibular neurectomy. T₁-weighted magnetic resonance images (upper) and with gadolinium (lower) obtained 149 days after vestibular neurectomy demonstrating linear enhancement along the anterior wall of the internal auditory canal (arrowheads) and an enhanced mass confined to the drilled petrous bone (arrow).

Discussion

I. Benign postoperative enhancement on MR imaging

Enhancement of the brain parenchyma, leptomeninges, dura, or packing materials including muscle at uncomplicated cranial postoperative sites is well known.²,³,⁵,⁷,¹⁰ Benign postoperative enhancement on MR images is generally considered to be caused by hypervascularization, disruption of the blood-brain barrier, luxury perfusion, or development of thick granulation tissue and neovascularity.³,⁷ However, such benign postoperative enhancement may be difficult to distinguish from residual or recurrent tumor. Evaluation of contrast-enhanced MR images in 46 patients after major intracranial surgery showed that parenchymal and meningeal enhancement with Gd-DTPA at the cranial operative sites was more extensive and persisted much longer than was commonly seen by contrast-enhanced CT.³ Diagnosis of infection or recurrent tumor in the first several months after surgery should be based on MR imaging with extreme caution because of the extensive and prolonged enhancement patterns commonly seen during this period. Study of postoperative MR imaging of patients who underwent resection of a high-grade glioma found that MR imaging during days 1 to 3 after surgery was extremely valuable for assessing gross residual tumor.²¹ This timing minimized interpretative difficulties because benign postoperative enhancement usually appeared on day 4 or later. Animal and clinical studies to examine the
appearance of surgical trauma and biodegradable packing on enhanced MR imaging showed that intracranial surgical trauma and biodegradable surgical materials including Gelfoam (Upjohn, Kalamazoo, Mich., U.S.A.) resulted in areas of enhancement on the postoperative MR images in animals, and histological examination of these areas showed an inflammatory cellular response and neovascularity.7) The clinical study suggested that the diagnosis of residual or recurrent tumor should be assessed through a change in the pattern of enhancement rather than simply its presence. Analysis of postoperative MR imaging on the 1st day after surgery (range 17–28 hours) in 11 patients without intracranial neoplastic disease who underwent temporal lobectomies for medically intractable epilepsy showed that contrast enhancement of non-neoplastic brain parenchyma could occur postoperatively within 17 hours.9)

The present study found dural and leptomeningeal contrast enhancement at the operative field in all five patients who underwent postoperative MR imaging within the first 2 days after removal of an acoustic neuroma. Our results confirm that benign contrast enhancement can occur at the surgical site in the immediate postoperative period. Postoperative benign enhancement appeared in various regions including the leptomeninges over the cerebellar hemisphere, dura along the posterior surface of the petrous bone, the cerebellar tentorium, or dura within the IAC. However, no intraparenchymal enhancement was observed in this series since acoustic neuromas are purely extraaxial. Our results indicate that masslike enhancement, which is difficult to distinguish from residual tumor, rarely appears in the cerebellopontine angle outside the IAC after surgery.

Benign postoperative nodular enhancement within the IAC can mimic residual or recurrent tumor on postoperative MR imaging. The IAC is almost always filled with neuroma preoperatively, so whether the enhanced mass within the IAC can be purely benign and unrelated to tumor is controversial. Serial MR imaging showed a change from nodular to linear enhancement in some of our patients with muscle repair of the IAC. Postoperative MR imaging of patients without neoplastic diseases who had undergone vestibular neurectomy also showed nodular enhancement of the muscle packed into the drilled petrous bone. Therefore, muscle at the surgical site can appear as contrast enhancement, so nodular enhancement on postoperative MR images does not necessarily indicate residual or recurrent tumor. Contrast enhancement at only the drilled petrous bone covered with a muscle piece with an empty IAC can be considered benign. In general, when a muscle piece is used to cover the opened IAC after removal of an acoustic neuroma, benign enhancement is extremely difficult to differentiate from tumor by a single MR imaging examination. Our results indicate that contrast enhancement in the muscle piece, in contrast to the dura or leptomeninges, does not appear on MR images obtained within the first 2 days after surgery. Therefore, MR imaging evidence of an enhanced mass in the IAC during the immediate postoperative period may be indicative of residual tumor.

II. Packing materials for the IAC

In our series, there were no cerebrospinal fluid leaks during the follow-up period. Therefore, we advocate fibrin glue as the packing material because of easy use and absence of masslike enhancement on postoperative MR images. However, cerebrospinal fluid leaks are more likely to occur if well-developed mastoid air cells extend into the posterior wall of the IAC or the air cells are obviously opened during drilling of the petrous bone. Under such conditions, a muscle piece in addition to fibrin glue should be used to reinforce against leakage, preferably confined to the drilled posterior wall of the IAC where cerebrospinal fluid leakage may originate and not inside the IAC. Such positioning of the muscle piece will help to distinguish between tumor and benign enhancement.

III. Follow-up MR imaging after surgery for acoustic neuromas

Postoperative MR imaging in 60 patients who underwent resection of malignant gliomas to compare the surgeon’s estimate of residual tumor with the indicating of residual tumor on postoperative MR images showed that MR imaging was much more sensitive and that regrowth arose from residual tumor already detectable in the early postoperative MR images in most cases.10) Early postoperative MR imaging is useful for evaluating the extent of surgery and for predicting the clinical course. Assessment of nerve function or recurrence rates after acoustic neuroma surgery requires correlation with MR imaging. Postoperative MR imaging in 13 patients who underwent acoustic neuroma resection via the middle fossa approach showed frequent enhancement at the operative site which was difficult to conclusively differentiate from residual or recurrent tumor by a single examination, so serial studies were recommended to identify changes indicating tumor growth.8) Postoperative MR imaging in 31 patients who underwent total removal of acoustic neuromas showed four patterns of features: IAC with nonen-
hancing soft-tissue strands; IAC with peripheral linear enhancement; IAC with globular enhancing tissues; and IAC with high signal intensity on unenhanced T1-weighted images. The nonenhancing soft tissue strands may have consisted of scars or distorted nerves, and the linear contrast enhancement may have corresponded to dural inflammation, so such features are indicative of complete tumor removal. Annual follow-up MR imaging was recommended for globular enhancement. Postoperative MR imaging of 36 patients in whom acoustic neuromas had been removed via various surgical approaches showed IAC enhancement in four grades as follows: linear, peripheral, and thin (pattern 1); linear, peripheral, and thick (pattern 2); nodular (pattern 3); or masslike (pattern 4). Enhancement of the IAC was seen on the first postoperative MR imaging study in all patients and IAC enhancement remained the same or decreased over time in 30 patients, suggesting that linear enhancement of the IAC was probably normal after surgery and that nodular and masslike enhancement or progressive enhancement requires close follow-up to evaluate for residual tumor.

However, whether the contrast enhancement at the surgical site is surgically-induced or tumor-induced remains unclear. In general, globular or nodular enhancement in the IAC seen on postoperative MR imaging can be definitely regarded as residual or recurrent tumor only after repeat MR imaging shows progression. The present study suggests that Gd-enhanced MR imaging within the first 2 days after surgery does not demonstrate such benign contrast enhancement and reveals the exact extent of surgery. Follow-up MR imaging at 6-month or yearly intervals is indicated if immediate postoperative MR imaging reveals nodular enhancement at the surgical site.

References


Address reprint requests to: H. Umezu, M.D., Department of Neurosurgery, Toranomon Hospital, 2-2-2 Toranomon, Minato-ku, Tokyo 105-8470, Japan.

Commentary

Drs. Umezu and Seki are to be congratulated for addressing a very important and practical matter in acoustic tumor surgery and shed light on other tumor...
surgery in the posterior fossa. They address the type of postoperative MRI abnormalities, the relation of these abnormalities to the nature of the graft used in the internal auditory meatus, and the subsequent evolution of these changes on long-term follow-up MRI. All of this information is important for surgeons who deal with acoustic tumors.

One important matter that was not emphasized in their article is the use of fat graft. A small piece of fat for such use can be obtained from a minute incision in the abdomen without any significant morbidity. The advantage of the fat is that MRI appearance is so characteristic and MRI fat suppression sequences can be obtained, that makes it very distinguishable without the concern of muscle graft confusion with tumor. Fat also tends to shrink with time and that also will help in long-term follow-up.

Ossama Al-Mefty, M.D.
Department of Neurosurgery
University of Arkansas School of Medicine
Arkansas, U.S.A.

Assessment of postoperative MR images after acoustic neuroma surgery often presents difficult problems because it is not always easy to distinguish the residual tumor from the packing material in the internal auditory canal (IAC) or surgically induced contrast enhancement. In this article, the authors classified postoperative MR imaging findings of the IAC into four enhancement patterns and evaluated the serial changes. They advocated fibrin glue as the packing material in the IAC because it showed nodular enhancement less frequently. If the mastoid air cells are obviously opened, they stated that a muscle piece with fibrin glue is better to prevent cerebrospinal fluid leak. However, they recommended MR images should be taken within the first two days after surgery to differentiate benign postoperative enhancement from remaining tumor. These results provide valuable information concerning which group of patients may need periodic follow-up MR imaging for evaluating regrowth of the tumor.

Norio Arita, M.D.
Department of Neurosurgery
Osaka University Medical School
Osaka, Japan

The authors should be commended for a very interesting and useful study of MR imaging after acoustic neuroma surgery. Everyone who has been dealing with this kind of neurosurgery is familiar with the problems of total excision of the very last parts of the tumor from the internal auditory canal (IAC). The reasons for that are in the tumor itself: extension of the tumor to the very end of the IAC, adherence of the tumor to the surrounding nerves, consistency of the lesion and variations of the surrounding bony structures. The pneumatized petrous bone in the vicinity of the IAC as well as the proximity of semicircular canals may prevent safe drilling of the walls of the IAC into the lateral direction. Whenever the IAC cannot be widely opened, the complete excision of the tumor is questionable. Hence, the objective imaging of a possible rest tumor immediately after surgery is of paramount importance for an objective follow-up and for the visualization of a possible recurrence of the tumor, since the planning of the follow-up imaging for rest tumor is different from that for a completely resected lesion. Beside studying the differences in images with fibrin glue or pieces of muscle in the IAC without the rest tumor and on the other hand, with the rest tumor, the authors also pointed out that complete MR imaging without and with contrast media is most valuable on the first postoperative day. This is why this report carries not only a purely scientific but also a very practical message to all neurosurgeons practicing in the domain of acoustic neuromas.

Vinko V. Dolenec, M.D.
Department of Neurosurgery
University Hospital Center
Ljubljana, Slovenia

Implanted surgical materials have always been a problem in discriminating tissue reaction artifacts from tumor residues in brain tumor surgery. The authors followed postoperative MRI in patients with acoustic neurinoma, and concluded that contrast MRI performed within 2 postoperative days could discriminate a muscle piece for prevention of CSF leakage. This conclusion is clinically valuable not only in the acoustic tumors, but in all brain tumor surgery. The authors suggested that fibrin glue demonstrated better results in the artifact on MRI. However, the use of fibrin glue alone may not be adequate for prevention of CSF leakage, because the surface of the bone resection is sometimes invisible from the suboccipital craniotomy. Using a surgical mirror or an endoscope will be useful to find opened air cells. A piece of fat tissue is recommended for the packing material to minimize tissue reaction artifacts.

Takeshi Kawase, M.D.
Department of Neurosurgery
School of Medicine
Keio University
Tokyo, Japan

The authors analyzed postoperative MRI after removal of vestibular schwannomas through a suboccipital transmeatal approach to differentiate residual tumor from benign postoperative Cd-enhanc-
cement. After total removal of the tumor, the opened internal auditory canal (IAC) and drilled mastoid air cells were packed either with muscle piece or with fibrin glue to prevent postoperative CSF leaks.

Postoperative MRI was studied within the first 2 days after surgery in 5 patients. Dural and leptomeningeal enhancement was detected in all patients without enhancement of the muscle piece and other tissues in the IAC, suggesting that early postoperative MRI was useful for evaluating the extent of surgery and confirming the presence of residual tumor. When postoperative MRI was obtained initially on day 3 or later, the packed muscle piece in the IAC showed nodular enhancement in all the cases studied.

Follow-up MRI for a long term showed the incidence of nodular enhancement in patients with muscle packing was significantly higher (3 out of 7 cases) than in patients with fibrin glue (2 out of 8 cases). It is usually difficult, due to this nodular enhancement, to differentiate the residual or recurrent tumor from surrounding structures, such as cranial nerves, dura mater, and muscle piece packed in the mastoid air cells and IAC. The muscle piece, however, can be identified by its position and time course on repeated MRI, which shows a change from nodular to linear enhancement in most cases after total removal of tumor, as shown in Fig. 3 of Case 1.

When an enhancing nodule persists on follow-up MRI, careful observation would be necessary. As for the residual tumor, it is important to confirm intraoperatively the extent of tumor removal before dural closure. In cases of insufficient drilling of the posterior wall of IAC, endoscopic observation is helpful to confirm radicality of tumor removal around the lateral end of IAC. In attempting to diagnose the presence of residual tumor after surgery, heavily T2-weighted MRI printed in reverse on films1) is recommended in addition to T1-weighted MRI with Gd enhancement.

Reference


Takashi OHMOTO, M.D.
Department of Neurological Surgery
Okayama University Medical School
Okayama, Japan