Magnetic Resonance Imaging after Translabyrinthine Complete Excision of Vestibular Schwannomas

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Abstract

The objective of this study is to determine whether magnetic resonance imaging (MRI) at 2 years following complete vestibular schwannoma (VS) excision using a translabyrinthine approach is sufficient to detect recurrent tumor. The study is set in a tertiary referral skull base unit. A service evaluation of a prospective database identified patients who underwent complete translabyrinthine VS excision with prospectively recorded MRI results at 2 and 5 years following surgery. The main outcome measures were evidence of tumor recurrence on MRI at 2 and 5 years after surgery. Of 314 patients in the study, all patients where MRI was reported to show no recurrence at 2 years (97%) also had no signs of recurrence on MRI at 5 years. All eight patients with MRI suspicious of recurrence (linear enhancement of internal auditory canal [IAC]) at 2 years had no progression on MRI at 5 to 15 years. One patient had evidence of definite recurrence (nodular enhancement of IAC) at 2 years, who went on to have radiosurgery at 8 years. Where patients have MRI with no linear enhancement of the IAC at 2 years, no further imaging is required. Where linear enhancement is seen, no change in enhancement at 5 years is reassuring and no further imaging is required.

Keywords

- ▶ vestibular schwannoma
- ▶ magnetic resonance imaging
- ▶ follow-up studies
- ▶ postoperative period

Surgical excision of vestibular schwannomas (VS) aims to achieve complete tumor resection while minimizing morbidity, in particular to the facial nerve.¹ Translabyrinthine resection offers complete access to the internal auditory canal (IAC), resulting in low rates of recurrence where complete tumor excision is achieved.² While complete tumor resection is achieved in the majority of the cases, residual tumor may occasionally be left to preserve the integrity of the facial or other cranial nerves or due to adherence of the tumor to the brainstem. Where near-total or subtotal excision is achieved, there is a general consensus that long-term serial imaging with Magnetic Resonance Imaging (MRI) is indicated to ensure that there is no growth of residual tumor.^{1,3,4} However, opinions differ on the optimum timing of MRI after complete excision of

VS and whether a single MRI or serial imaging is required to detect recurrent tumor.^{3–6}

MRI offers the most accurate means of assessing patients for recurrent VS as clinical signs are only likely with large volume tumor recurrence.⁷ Interpretation of these images can be challenging as differentiation of recurrent tumor and postoperative scar tissue can be difficult. Nodular or progressive enhancement of the IAC is indicative of recurrent tumor, whereas linear enhancement has been shown not to be associated with recurrent tumor.⁴ Our unit has operated a policy of performing MRI routinely at 2 and 5 years following VS excision in patients where complete tumor excision has been achieved. We aim to determine whether, in patients with no signs of recurrent tumor on MRI at 2 years postoperative, a further MRI is necessary at 5 years. We also assess the

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likelihood of recurrent tumor in patients where suspicion of recurrence due to enhancement of the IAC is reported at MRI 2 years following the surgery.

Materials and Methods

The outcomes of patients who had undergone VS surgery by the senior author were prospectively recorded in a database. Patients were included into this study where they had undergone translabyrinthine resection of VS, complete excision had been achieved and the results of postoperative MRI at both 2 and 5 years after surgery were prospectively recorded in a database. Patients were excluded where near-total (<1% of tumor left), subtotal tumor excision (1–5% of tumor volume left), or debulking (>5% of tumor left) was performed. Patients with neurofibromatosis type 2 were also excluded as they undergo long-term MRI head for tumor surveillance.

Gadolinium enhanced T1 weighted MRI centered on the IAC was performed at 2 and 5 years after surgery. Scans performed at our institution were axial fat-suppressed T1-weighted spin echo sequences after IV gadolinium with 2 mm slice thickness and 0.5 mm gap. Imaging was initially reviewed by neuroradiology consultants and then by the senior author or neurotology fellows. Where discrepancy occurred, a consensus was achieved by joint imaging review. MRI performed at outside institutions were performed according to their local protocols and initially reviewed by radiologists locally before further review of the images by the senior author or neurotology fellows at our institution.

Linear enhancement of the IAC, whether feint or avid, was interpreted as suspicious of recurrence and plaque like or nodular enhancement was interpreted as definite recurrence. Where data were missing, retrospective review of imaging was not performed as many of the images were no longer available and to prevent the bias this would have introduced. Patient demographics, maximum tumor diameter in the axial plane after surgery, and MRI findings at 2 and 5 years after surgery were analyzed. Further MRI outcomes and case notes review were performed in patients where linear or nodular enhancement was reported on MRI. Where no progression was observed, these patients were monitored by MRI annually for 3 years, biannually for 6 years, and triannually thereafter. Patients where growth of recurrent tumor was observed, as determined by progressive growth of nodular enhancement at the IAC, were considered for further treatment.

Results

A total of 314 patients met the criteria for inclusion in this study. There were 168 females and 146 males with a median age of 54 and range of 20 to 85 years. These patients all underwent translabyrinthine complete resection of VS between 1983 and 2005. The majority of tumors were between 16 and 25 mm in maximum tumor diameter in the axial plane (—Fig. 1). Three hundred and one patients were excluded due to lack of imaging result recorded at 2 or 5 years after surgery.

Figure 1 Diameter of vestibular schwannoma at surgical excision.

A further 3.5% of patients who had undergone near-total and 1.3% subtotal excision were then excluded. Over the course of this study, images were reviewed by one of nine neuroradiology consultants followed by either the senior author or one of 25 neurotology fellows. Although the vast majority of patients underwent postoperative MRI at our institution, exact data were not available regarding the number of MRI scans performed at outside institutions or the rare cases where a discrepancy of opinion interpreting MRI occurred.

MRI at 2 years following surgery was suspicious of recurrence due to linear enhancement of the IAC in eight (2.5%) patients (—Table 1), which had resolved by 5 years in three patients and by 10 years in one patient. No change in enhancement was seen in the remaining four patients at MRI 5, 7, 10, and 15 years, respectively. One patient (0.3%) had definite recurrence at 2 and 5 years as indicated by nodular enhancement of the IAC on MRI. The VS was found to be adherent to the brainstem at the time of surgery, although macroscopic clearance had been achieved. Following growth of the recurrent tumor, treatment with stereotactic radiosurgery was required 8 years later, resulting in good control after a further 8 years follow-up to date.

Discussion

Opinions differ as to the optimum timing of MRI after complete resection of VS, with initial imaging recommended from as early as 1 month⁸ to as late as 5 years after surgery.⁶ MRI earlier than 1 year after VS excision is likely to show enhancement of the IAC due to postoperative inflammation during the healing process.⁴ While this may be used as a baseline for comparison with later imaging, our data support the need for only one postoperative MRI as all of our patients where no enhancement of the IAC was reported at 2 years also had no enhancement at 5 years.

Our results suggest that the timing of the postoperative scan is not critical and could be performed at either 2 or 5 years as, even when linear enhancement was seen at 5 years, no progression was seen on later scans. However, patients

Table 1 Appearance of IAC on MRI Following Translabrynthine Complete Resection of VS

	Enhancement of IAC	MRI at 5 Years Postoperative		
		None	Linear	Nodular
MRI at 2 years postoperative	None	305	0	0
	Linear	3	5	0
	Nodular	0	0	1

IAC, internal auditory canal; MRI, magnetic resonance imaging.

need to be reassured that they are tumor free. A scan at 2 years after surgery is able to achieve this in the vast majority of patients, rather than waiting for a further 3 years. When considering those patients where imaging was suspicious of recurrence due to linear enhancement, we agree with Bennett et al that only one further MRI is necessary to ensure that there is no increase in the level of enhancement, although they advocate initial imaging at one rather than 2 years. Persistent enhancement after VS resection has been proposed to be the result of scarring of the dura.⁴ Our data support this hypothesis as linear enhancement at 2 years had resolved by 5 years in three of the eight patients where this was observed.

Nodular enhancement indicates recurrent disease.^{9,10} Our recurrence rate of 0.3% is the same as that reported by Bennett et al, where one patient out of 297 who had undergone translabrynthine complete resection had nodular enhancement on MRI at 1 year.³ Shelton also reported the same recurrence rate in a larger series, although the mean time to recurrence was 10 years.² Roche et al suggest that serial MRI scans for up to 20 years are necessary on the basis of their far higher rate of recurrence of 9.2% when patients were imaged between 8 and 16 years after translabrynthine resection.⁵ However, their series also included patents that had undergone subtotal excision. When considering the long time to recurrence of the majority of VS, a single MRI at 10 to 15 years after surgery could be considered. However, we agree with Schmerber et al that this is not justified as they identified no recurrent tumors after MRI with a mean follow-up of over 10 years⁶ and that the majority of the patients with late recurrence identified by Shelton presented with clinical symptoms.² In addition, leaving such a long interval before imaging is likely to result in poor compliance as patients are lost to follow-up over time, making it less likely that the rare cases of recurrence would be identified.

Although this is one of the largest series reported in terms of MRI after translabrynthine complete excision of VS, it has several limitations. This is a retrospective study over a long period of time. The main flaw is the exclusion of nearly half of the patients potentially eligible due to the lack of postoperative imaging data. Although these patients did undergo postoperative MRI at 2 and 5 years, the results were not recorded in the database at the time and were no longer available for review. Another issue is the inability to control for interobserver error in terms of interpreting the MRI due to the long period of time over which this study spans, which included several neuroradiologists and many neurotology fellows. However, all clinicians involved were experienced

in interpreting these images. While the majority of patients underwent MRI at our institution, some were performed at other hospitals. We were unable to control for the variation in imaging protocols and initial interpretation by radiologists outside of our institution. The quality of MRI has also improved considerably over the course of this study and it is possible that there may be patients with scans reported as normal where an abnormality would be seen using current scanners and protocols.

While the paucity of abnormal findings on imaging limit statistical analysis, our data demonstrate that abnormal enhancement of the IAC is rare after complete translabrynthine excision of VS. Assuming that the true recurrence rate after translabrynthine complete excision of VS is 0.3%, 333 patients would need to be imaged to identify one recurrent tumor. This could make postoperative MRI difficult to justify in terms of the cost-benefit, although we have not performed formal analysis. However, both clinician and patient alike would be uncomfortable without the reassurance that postoperative imaging provides. On this basis, we continue to advocate performing MRI to detect recurrent disease given the implication of this for the patient and the fact that clinical signs are unlikely to develop until significant growth had occurred, which may be many years later.^{2,7}

Conclusion

We recommend a single MRI after translabrynthine complete resection of VS. Whether this MRI is performed at 1 year,³ 2 years, or 5 years⁶ is probably not important, although we would advocate early imaging at 2 years after surgery to identify those patients who are at risk of recurrence and to achieve maximum compliance with imaging. Patients where nodular enhancement is seen should be considered to have recurrent disease. Where MRI shows suspicion of recurrence due to linear enhancement, patients should have another MRI at 5 years. If this shows no progression, they can be reassured and no further imaging is required.

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