The Prevalence of “Incidental” Acoustic Neuroma

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**Objective:** To estimate the prevalence of “incidental” acoustic neuromas (ANs) in the population at large.

**Design:** An intracranial magnetic resonance imaging (MRI) database of 46,414 patients presenting to the University of California, San Francisco (UCSF), without known audiovestibular complaints was searched retrospectively from July 1995 to February 2003. Seventy percent of these MRIs included gadolinium, and none was specifically targeted through the internal auditory canal. A medical chart review of 688 patients with acoustic neuromas presenting to UCSF between 1980 and 1999 was searched for sex distribution.

**Setting:** Tertiary care university medical center.

**Results:** Eight patients with incidental AN were discovered. This figure suggests that undiagnosed ANs may be present in at least 0.02% of the population. Three patients were found to have audiovestibular symptoms on inquiry after diagnosis. Audiometry revealed asymmetry at 4 kHz in only 3 of 7 patients, with an otherwise symmetric audiogram in the remaining patients. Tumor size in this population ranged from 3 to 28 mm. Incidental ANs were more common in men, but ANs were more common in women overall.

**Conclusions:** The prevalence of incidental AN appears to be roughly 2 in 10,000 people. This figure indicates that AN may be less prevalent than suggested in previously reported temporal bone studies and more prevalent than suggested by epidemiologic studies.

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**ACOUSTIC NEUROMAS (ANS) represent approximately 6% of all intracranial tumors and are thought to have an incidence of 0.3 to 1 per 100,000 population per year.**

The use of thin-section gadolinium-enhanced magnetic resonance imaging (MRI) as the screening method for evaluation of retrocochlear disease has allowed diagnosis of ever smaller tumors, many of which are associated with subtle, if any, symptoms. This early diagnosis not only allows patients more treatment options but also potentially improves outcome, especially in the functional preservation of the auditory and facial nerves. However, a subset of the population is currently living with undiagnosed ANs and may be diagnosed only after undergoing MRI for nonneurotologic reasons.

**METHODS**

Using a radiology database (IDXRad), we entered the keywords “vestibular schwannoma” and “acoustic neuraoma” to search for AN diagnosed between July 1995 and February 2003. Magnetic resonance images of the internal auditory canal (IAC) and skull base were not included. There were 46,414 intracranial MRIs performed (32,255 with gadolinium, 14,159 without) revealing 505 patients with AN. The medical charts for these 505 patients were hand searched for a clinical history that did not include audiovestibular abnormalities. Patients were excluded if they had an audiogram indicating hearing loss or if they complained of hearing loss, vertigo, or tinnitus prior to any radiographic imaging (computed tomography or MRI). Data collected included sex, age, reason for MRI, size of AN, and audiometry. Magnetic resonance images of incidental ANs were reviewed by a senior neuroradiologist. For sex distribution, we reviewed the charts of 688 patients with ANs who presented to University of California, San Francisco (UCSF), between 1980 and 1999.

**RESULTS**

All 8 incidental cases were detected on MRI obtained for a reason other than suspicion of AN, such as headache or seizure. All 8 cases were found on MRIs with gadolinium; none was found on noncontrast scans. Audiometry revealed asymmetric hearing loss in only 3 of 7 patients who...
had audiograms, with an otherwise symmetric audiogram in the remaining patients (Table 1). Tumor size in this population ranged from 3 to 28 mm (mean size, 13.8 mm). The average patient age was 58 years (age range, 20-83 years). There were 6 men and 2 women. The prevalence of incidental ANs was approximately 2 in 10000 adults. By reviewing the charts of 688 patients who presented to UCSF with ANs, we found that there were slightly more women (53%) than men (47%).

CASE 1
A 50-year-old man who underwent an MRI during a workup for a chronic seizure disorder was found to have a 22-mm right-side AN. Audiometry showed a normal pure tone average and word recognition score (WRS) but 20-dB asymmetry in speech reception threshold.

CASE 2
An 80-year-old man presented with left hemifacial spasm. His MRI showed a 10-mm right-side AN. On further questioning, he revealed that he had had contralateral stable profound deafness on the right for more than 10 years. Audiometry showed profound deafness on the right with severe high-frequency hearing loss.

CASE 3
A 20-year-old man presented with unilateral epistaxis and underwent MRI, which revealed a right juvenile angiofibroma and a 10-mm left-side AN. He denied audiovestibular symptoms and had a normal audiogram.

CASE 4
A 48-year-old woman had an AN discovered during a workup for breast cancer metastases. Magnetic resonance imaging revealed a 28-mm left-side lesion, and an audiogram showed normal hearing and WRS bilaterally.

CASE 5
A 54-year-old man presented with left-sided Horner syndrome and internal carotid dissection. An incidental, ipsilateral, 7-mm AN was found on MRI. On further questioning, the patient reported left-sided progressive hearing loss over the last 10 to 12 years. His audiogram showed mild to severe asymmetric hearing loss and 44% WRS on the left.

CASE 6
A 74-year-old woman with a history of bilateral subdural hematomas presented with new-onset right hemiparesis. An MRI obtained as part of a stroke workup revealed a 17-mm AN. No audiogram or further history was available for this patient.

CASE 7
A 59-year-old man underwent MRI during a workup for a dizziness spell. His MRI revealed a 13-mm right-side lesion, and his audiogram revealed mild to moderate/severe asymmetric hearing loss and 72% WRS on the right. He later reported a 3-year history of gradually progressive hearing loss on the right.

CASE 8
An 83-year-old man presented with a 10-minute episode of dizziness. As part of a workup for a transient ischemic attack, an MRI was obtained and revealed a 3-mm lesion. He denied any other episodes of dizziness and had a symmetric mild to moderate hearing loss and 90% WRS on the left.

COMMENT
Acoustic neuromas are most commonly associated with asymmetric hearing loss, tinnitus, and disequilibrium but have varied presentations. Examples of less common presentations include sudden hearing loss, tinnitus in the absence of hearing loss, subjective hearing loss with normal audiograms, tic douloureux, and subarachnoid hemorrhage.4-7

The most unusual presentation is the “asymptomatic pickup.”8-15 In our study, 0.02% of the population without suspicion of an AN were found to have an AN and often did not have an asymmetric audiogram. Several authors have attempted to calculate the prevalence of occult ANs. Reports have ranged from 0 to as high as 2.4%

Table 1. Incidentally Discovered Acoustic Neuromas

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Size, mm</th>
<th>Scan Indication</th>
<th>ASNHL</th>
<th>SRT, dB</th>
<th>WRS, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22</td>
<td>Seizure</td>
<td>No</td>
<td>20</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>Contralateral hemifacial spasms</td>
<td>Yes</td>
<td>40</td>
<td>88</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>Juvenile angiofibroma</td>
<td>No</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>28</td>
<td>Breast cancer metastasis</td>
<td>No</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>Horner syndrome</td>
<td>No</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>6*</td>
<td>17</td>
<td>Subdural hematoma</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>7</td>
<td>13</td>
<td>Dizziness</td>
<td>Yes</td>
<td>40</td>
<td>72</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>Transient ischemic attack</td>
<td>No</td>
<td>15</td>
<td>80</td>
</tr>
</tbody>
</table>

Abbreviations: ASNHL, asymmetric sensorineural hearing loss; NA, not applicable; SRT, speech reception threshold; WRS, word recognition score.

*Audiogram not available for this patient.
To hearing or the vestibular system. Leonard and Talbot studied the same 250 temporal bones plus an additional 240 bones and confirmed only 4 asymptomatic ANs, for a prevalence of 0.8%. These patients also were reported to lack symptoms referable to the auditory or vestibular system in their lifetime.

In 1975, Stewart et al. studied 893 temporal bones from 517 patients and found 5 occult ANs, revealing a prevalence of 0.9%. Only 1 patient truly did not have any auditory or vestibular symptoms. One patient was reported to have unexplained hearing loss in the left ear 2 weeks prior to death from uremic coma after stomach cancer resection. Another patient had hearing loss in both ears for many years but no history of vestibular symptoms. A woman had an audiogram consistent with presbycusis 4 years prior to her death from meningitis at age 67. The fifth patient complained of continuous left ear pain, discharge, and deafness for the last 3 years of his life.

Karjalainen et al. studied 298 temporal bones from 168 patients and found no occult ANs. In Japan, Ohtani et al. examined 746 temporal bones from 401 patients and discovered 5 ANs in 4 individuals, for a prevalence of 1%. Selesnick et al. prospectively studied 161 head MRIs of patients with diagnoses other than ANs or sensorineural hearing loss and found no occult ANs. The fifth patient continued to have hearing loss and obtained an MRI only when he developed hemifacial spasm.

In the present study, 46414 MRI reports were evaluated, and 8 previously undiagnosed ANs were found, suggesting a prevalence of 0.02%. Our study includes a larger and more diverse segment of the general population than has been previously studied. Therefore, our calculation of prevalence may be closer to the actual prevalence in the general population than the prior prevalence calculations based on temporal bone studies, which had far fewer cases and generally reflected an older population.

As the population ages, the incidence of acoustic neuromas in the entire population is expected to increase, which may explain the higher prevalence of ANs in cadaver temporal bone studies. Epidemiologic studies more likely reflect the general population and are not as heavily weighted to the older population and thus have lower prevalence estimates.

Our patient population is similar to that in the more recent study by Anderson et al., which was also a retrospective study. They reviewed 24246 MRIs (19405 with contrast, 4841 without contrast) of patients for whom an MRI was obtained for reasons other than suspicion of an AN and found the prevalence of incidental AN to be 7 per 10000 brain MRIs (0.07%). Two of the incidental cases of ANs were actually found in noncontrast studies. Our 2 groups had similar age demographics: the age range in the study by Anderson et al. was 26 to 74 years, with an average age of 56 years; our patient ages ranged from 20 to 83 years, with an average of 58 years.

However, the difference in prevalence between the study by Anderson et al. (0.07%) and the present study (0.02%) does not appear to be compatible with random variability (Fisher exact test \(P = .002\)). There are several possible reasons for the difference: (1) Anderson et al. evaluated fewer MRIs over fewer years (January 1993 to December 1997); and (2) the MRIs in their study did not specifically exclude MRIs of the IAC. An MRI of the IAC is usually obtained for audiovestibular complaints or suspicion of disease in the IAC—most often to rule out an AN. The difference might also be explained by population differences based on geography and regional referral patterns.

The present study population differed from the general population receiving brain MRIs. Our study population was older, with an average age of 58 years. The average age of the general population in our study was 44. This may reflect the increasing incidence of AN as the population ages. In addition, our study population also differed from the general population in sex distribution. The study population included 6 men and 2 women. The general population had 22067 men and 24347 women. By reviewing the charts of 688 patients who presented to UCSF with ANs, we found that there were slightly more women (53%) than men (47%). This suggests that ANs tend to be more common in women, although this difference is not statistically significant \(P = .11\). However, the incidental ANs were more common in men, even in a general population more weighted toward women. A possible explanation is that men might be less likely to seek treatment for audiovestibular complaints (as suggested by patient 2, who had a stable contralateral profound deafness and obtained an MRI only when he developed hemifacial spasm) or may be less likely to report minor audiovestibular symptoms to their physician.

The present study has several limitations. Our MRI database review specifically excluded MRIs of the IAC and skull base in an attempt to more accurately calculate the

### Table 2. Prevalence of Incidental Acoustic Neuromas Reported in Literature

<table>
<thead>
<tr>
<th>Source</th>
<th>Type of Study</th>
<th>Country</th>
<th>No. of Bones</th>
<th>No. of Cases</th>
<th>No. of ANs</th>
<th>Prevalence, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardy and Crowe, 1936</td>
<td>Retrospective</td>
<td>United States</td>
<td>250</td>
<td>No data</td>
<td>6</td>
<td>2.4</td>
</tr>
<tr>
<td>Leonard and Talbot, 1970</td>
<td>Retrospective</td>
<td>United States</td>
<td>490</td>
<td>No data</td>
<td>4</td>
<td>0.8</td>
</tr>
<tr>
<td>Stewart et al, 1975</td>
<td>Retrospective</td>
<td>United States</td>
<td>893</td>
<td>517</td>
<td>5</td>
<td>0.9</td>
</tr>
<tr>
<td>Karjalainen et al, 1984</td>
<td>Retrospective</td>
<td>Finland</td>
<td>298</td>
<td>168</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Otani et al, 1997</td>
<td>Retrospective</td>
<td>Japan</td>
<td>746</td>
<td>401</td>
<td>5 (4 patients)</td>
<td>1</td>
</tr>
<tr>
<td>Selesnick et al, 1999</td>
<td>Prospective</td>
<td>MRI</td>
<td>NA</td>
<td>161</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Anderson et al, 2000</td>
<td>Retrospective</td>
<td>MRI</td>
<td>NA</td>
<td>24246</td>
<td>17</td>
<td>0.07</td>
</tr>
<tr>
<td>Present study, 2003</td>
<td>Retrospective</td>
<td>MRI</td>
<td>NA</td>
<td>46414</td>
<td>9</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Abbreviations: AN, acoustic neuroma; MRI, magnetic resonance imaging; NA, not applicable.
prevalence of unsuspected ANs. The brain MRIs that were included tend to have thicker slices and wider interslice gaps than IAC studies, and therefore a radiologist not looking specifically for an IAC tumor might only pick up an incidental tumor if it is reasonably large. Furthermore, we reviewed the reports of 46414 intracranial MRIs, not the actual images, thus relying on the initial radiologist to detect the tumor and to dictate our search words into their report. Thirty percent of cases also did not use gadolinium, which would significantly decrease the detection rate of ANs. Even if we excluded noncontrast scans from our denominator, however, our estimate of the prevalence would still be low: 0.025%. Using this adjusted prevalence rate, one could assume that there might be 3 or 4 ANs (albeit small) in the remaining 11590 noncontrast studies. Particularly large lesions might still be picked up on noncontrast studies, especially on T2 images as a cerebrosplinal fluid filling defect. Finally, some of these lesions might actually have been facial nerve lesions rather than ANs, since diagnosis is not ultimately confirmed until the time of surgery or autopsy.

While the prevalence is 2 in 10000 for those undergoing MRI scans for reasons other than audiovestibular complaints, a small number of each 10000 population group will undergo MRI each year for audiovestibular complaints. Magnetic resonance imaging for those having audiovestibular complaints yields a tumor in about 1 in 100 cases. Thus, the overall prevalence includes both of these groups plus the patients who did not have gadolinium used on their scans and is therefore likely actually somewhat higher than 2 in 10000.

Early diagnosis should decrease patient morbidity owing to the higher likelihood of finding a smaller tumor with milder symptoms. A smaller tumor at diagnosis both increases treatment options for the patient and improves surgical outcome. Early diagnosis, however, depends on the presence of recognizable clinical symptoms. Our findings suggest that symptoms of AN are elusive and that incidental tumors remain a diagnostic challenge to the evaluating clinician.

The incidental discovery of an AN was made in almost 0.02% of our study group. These patients had not sought medical attention for their symptoms, if any, though audiometric assessment indicated suspicious asymmetry in 3 of the 7 patients with audiograms. After reviewing a large database of intracranial MRIs obtained for nonneurotologic reasons, we found the prevalence of AN to be roughly 2 in 10000 adults. This figure indicates that AN may be less prevalent than suggested in previously reported temporal bone studies and more prevalent than that suggested by epidemiologic studies.

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REFERENCES