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Case Report

Vestibular schwannoma of oscillating size: A case report and review of literature

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Abstract

Background: Vestibular schwannomas are benign brain tumors arising from the 8th cranial nerve with a varying natural history. Various reports have described discernable growth patterns for these tumors. However, growth predictability remains low because of slow and indeterminate changes over time with follow-up reports not usually exceeding 3 years. Our report describes the long-term follow-up of an unusual cystic schwannoma with growth patterns prior to and following treatment, adding valuable information to the variable natural history and outcome of these infrequent tumors.

Case Description: A 68-year-old gentleman presented with a left-sided cystic vestibular schwannoma, initially managed conservatively. Imaging revealed wide variations in the size of his tumor over a period of 3 years. He was finally treated with Gamma Knife radiosurgery, and at 1 year following treatment shows tumor shrinkage with a change in tumor morphology.

Conclusion: To our knowledge, the present case represents the first instance of a schwannoma showing wide fluctuations in tumor size and morphology over a period of time, with a good response to radiosurgery. We emphasize in this report that there is no "one size fits all" treatment paradigm for these tumors and each patient requires individualized care and intervention, taking into account their differing natural histories.

Key Words: Acoustic neuroma, cystic, oscillating, schwannoma

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INTRODUCTION

Vestibular schwannomas are benign brain tumors which are believed to arise from Schwann cells in the vestibular component of the 8th cranial nerve. These tumors have an incidence of about 10–15/million a year.[10,36] The greater use of cranial imaging studies for diagnosis and treatment of a variety of neurological conditions has given rise to earlier detection of these tumors and may contribute to an incidence rate that appears higher than was earlier thought. Early detection of small tumors results in a spectrum of size ranging from intracanalicular tumors to large extrameatal extensions of these tumors. The mean age at diagnosis in various published series ranges between 46 and 58 years, with occurrences in younger patients often associated with neurofibromatosis type 2 (NF-2). The clinical presentation varies depending on the size at diagnosis, presence of mass effect on the brain stem and whether there is any obstruction to cerebrospinal fluid (CSF) pathways.

Vestibular schwannoma management with minimal morbidity and mortality continues to remain a challenge. Charles Balance probably performed the first vestibular schwannoma removal in 1894,[11] followed by Cushing[1] who advocated the advantages of intracapsular debulking to avoid major morbidity and mortality associated with surgery in those days. Dandy reintroduced the concept of total tumor removal along with Olivecrona. Later on, William House[9] in the 1960s introduced the operating microscope for resecting vestibular schwannomas. Stereotactic radiosurgery and, in particular, the Gamma Knife was pioneered in the 70s by Lars Leksell[14] followed by Lunsford[13] who established the treatment parameters and efficacy of this procedure for long-term tumor control.

Today, both the patient and neurosurgeon have multiple treatment options available including observation, microsurgical resection and various radiotherapeutic modalities or a combination thereof to appropriately manage these tumors. In addition to avoiding major morbidity and mortality, the goals of treatment are also to achieve tumor control while preserving function of the cranial nerves. Health-related quality of life issues have also to be considered while treating these patients and it is up to the neurosurgeon to recommend all the options as well as the most appropriate treatment strategy in each individual case.

Vestibular schwannomas exhibit slow growth rates as reported previously in literature,[20] with overall mean growth rates ranging from 1.15 to 2.4 mm/year.[2] Nedzelski *et al*. reported 20% of their patients requiring surgery in the first third of their expected survival time and others report surgery in 6–24%[30,39] of their patients managed with a conservative strategy. Many consider a 2 mm increase in the greatest diameter clinically significant[26,28] to intervene with a 3 mm difference in two consecutive MR studies being an evident sign of tumor progression.[2,38] This, however, does not hold true for cystic schwannomas, comprising 11–24% of all vestibular schwannomas and reported to have rapid rates of tumor growth.[37] We describe an unusual case of a cystic vestibular schwannoma with wide fluctuations in size on imaging studies over a span of 3 years, our management strategy, and a literature review.

CASE REPORT

A 68-year-old, right-handed man presented with symptoms starting about 4 years prior to his diagnosis. He recalled having an episode of vertigo associated with nausea while he was deep sea diving. Thereafter, he developed progressive left-sided hearing loss as well as tinnitus associated with imbalance and a sway when he walked and climbed stairs. He was evaluated for these symptoms and imaging revealed an enhancing mass [23 (AP) × 25 (T) × 18 (CC) mm] [Figure 1] with central areas of cystic change within the left CP angle extending into the left internal auditory canal. The tumor was consistent with a vestibular schwannoma. It was decided to observe the tumor with repeat scans at timed intervals. He was scanned 2 months later when he had an improvement in his symptoms, with imaging revealing a decrease in the size [15.3 (AP) × 18.7 (T) × 11.7 (CC) mm]. Continued observation was recommended with no intervention planned. Repeat imaging done 6 months later revealed a further reduction in size [13 (AP) × 17.5 (T) × 10.4 (CC) mm] [Figure 2] and conservative management was continued.

About a year later, he had magnetic resonance imaging (MRI) of the brain done, which revealed a marginal increase in size [15 (AP) × 18.7 (T) × 11.5 (CC) mm] [Figure 3]. About 4 months later, re-imaging showed that the schwannoma had substantially enlarged [24.5 (AP) × 25 (T) × 17.5 (CC) mm] [Figure 4]. An audiometric evaluation at this time revealed a moderate to severe sensorineural hearing loss in the left side. Speech discrimination scores were very poor at 28% on the left side and 96% on the right. The patient decided not to undergo any treatment and had a repeat scan 5 months later that again showed a decrease in the size of the left acoustic neuroma [15 (AP) × 18 (T) × 12 (CC) mm] [Figure 5] with internal acoustic canal (IAC) extension being stable at 5–6 mm. There was neither hydrocephalus nor brain stem compression although the tumor was abutting the cerebral peduncle. He had decreased sensation over the left side of his face and no hearing on the left side, with gait imbalance and a sway to the left. The volume of the tumor was calculated using the formula [Antero-posterior(AP) × transverse(T) × cranio-caudal(CC)/2] and the trend in volume changes over time is depicted in Figure 6. Although Kameyama *et al*. classified cystic vestibular schwannomas into three types based on MRI findings, we could not place the patient in a particular subgroup because MRI findings were suggestive of a transition between all three subgroups over a period of time, prior to treatment.

It was at this time that we recommended intervening using stereotactic radiosurgery because we felt a smaller tumor would likely have the best balance between response and risk. We also discussed all the available treatment options including further observation and microsurgery.

He underwent Gamma Knife radiosurgery and received 13 Gy to the 51% isodose line using 29 shots with a conformality index of 1.2. The dimensions on the day of treatment including the intracanalicular component were [15 (AP) × 17 (T) × 13 (CC) mm] [Figure 7]. He is on regular follow-up with MR imaging, and at 1 year since Gamma knife radiosurgery(GKRS), his images show

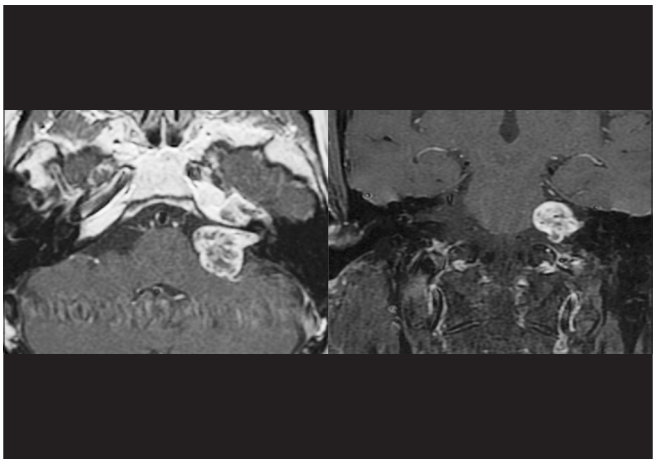

Figure 1: Axial and coronal contrast-enhancing T1WI showing a left CP angle enhancing mass with intrameatal extension and cystic changes measuring mass 23 × 25 × 18 mm on presentation in September 2007

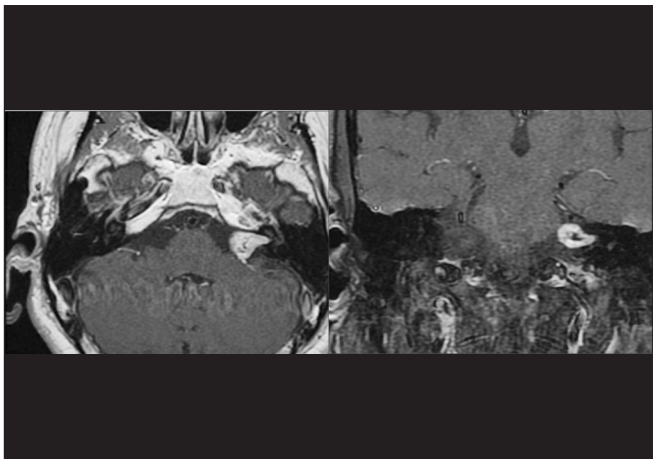

Figure 2: Axial and coronal contrast-enhancing T1WI in May 2008 with tumor measuring 13 × 17.5 × 10.4 mm

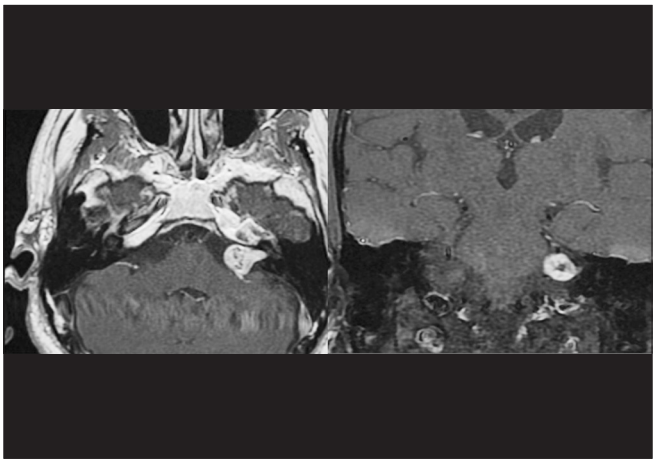

Figure 3: Axial and coronal contrast-enhancing T1WI in May 2009 with tumor measuring 15 × 18.7 × 11.5 mm

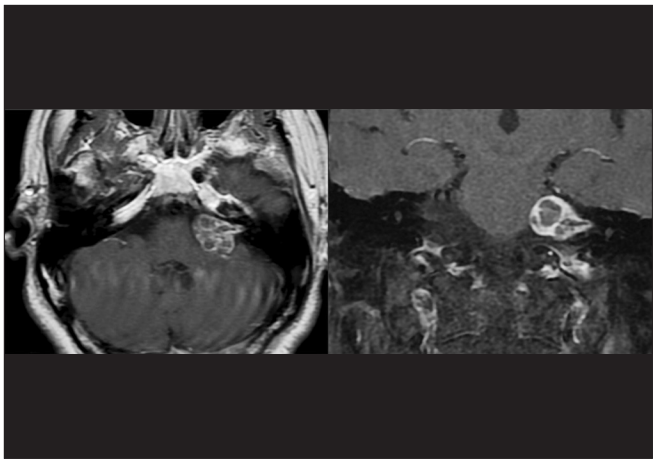

Figure 4: Axial and coronal contrast-enhancing T1WI in September 2009 with tumor measuring 24.5 × 25 × 17.5 mm

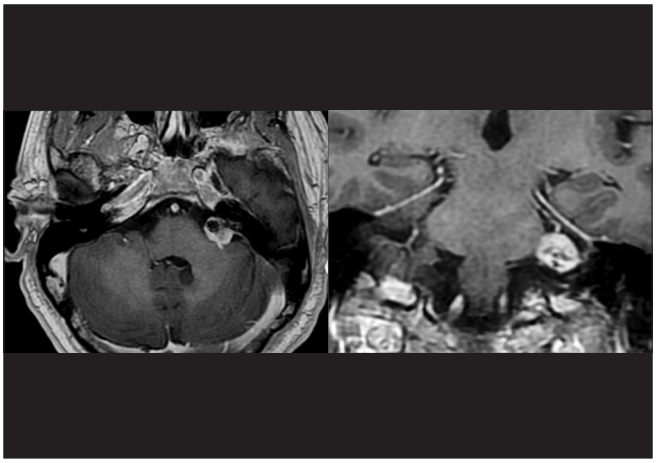

Figure 5: Axial and coronal contrast-enhancing T1WI in February 2010 with tumor measuring 15 × 18 × 12 mm

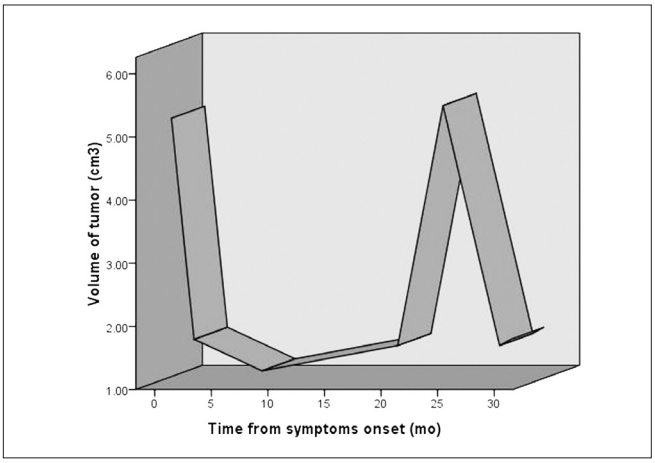

Figure 6: Graphical representation of tumor volume over time

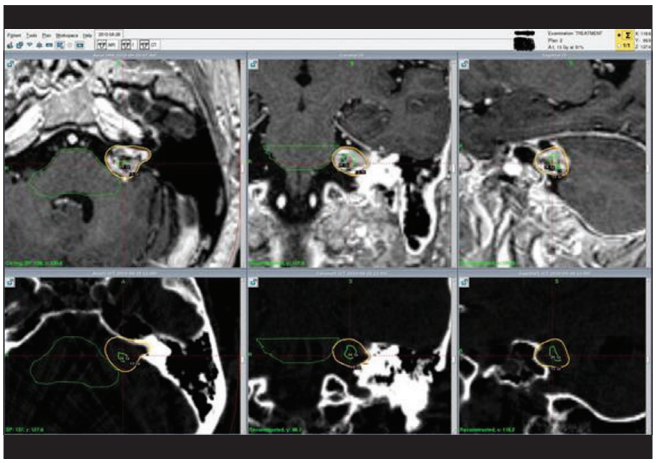

Figure 7: GKS plan March 2010

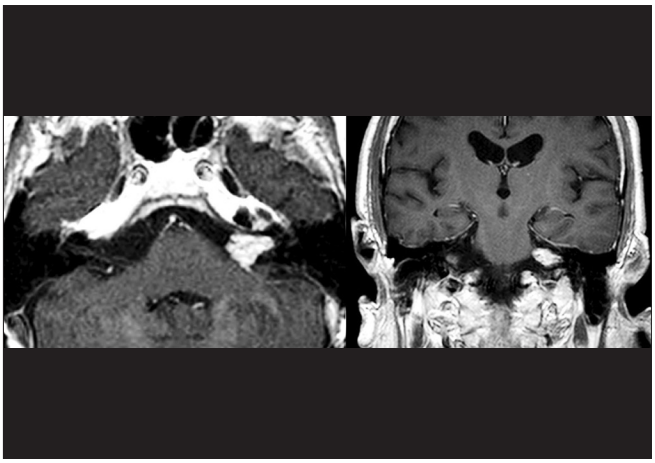

Figure 8: Axial and coronal contrast-enhancing T1WI in May 2011 with tumor measuring 15 × 11 × 9 mm

a solid tumor without any cystic component, measuring [15 (AP) × 11 (T) × 9 (CC) mm] [Figure 8] and he remains clinically stable.

DISCUSSION

Vestibular schwannomas have been evaluated for their growth rates over periods of time with clinical as well as imaging findings. The natural history remains variable with some tumors showing growth, some remaining stationary and a few even shrinking.[35] The tumors that grow will over time cause cranial nerve compromise, brainstem compression and possible hydrocephalus with associated neurological signs and symptoms. About 30–90% of these tumors have been reported to have mean growth rates varying between 0.25 mm/year and 3.2 mm/year.[26,34] In a recent meta-analysis, an average growth rate of 1.9 mm/year has been reported.[34] The growth rates could also vary between those tumors which are only intracanalicular and those that have extended and grown in the cerebello-pontine (CP) angle.

Factors which influence tumor growth include rates of cellular proliferation, hemorrhage, and infarction, alterations in blood supply, cystic degeneration or presence of cystic tumors.[3] Various classification systems have been put forward to describe cystic schwannomas.[23] These tumors are more aggressive, have a shorter duration of symptoms at the time of presentation, poorer outcomes with microsurgical resection and variable responses to radiosurgery.[4,6,8,12,29,32] The various reasons put forward for rapid tumor growth are possibly necrosis within the tumor core, repeated episodes of intratumoral hemorrhage and coalescence and rupture of microcysts within the tumor.[5,22] Possible osmotic gradients by extravasation of serum proteins or mucinous material production within the cyst can be the cause of later growth. Recently, enzymes like matrix metalloproteinase-2 (MMP-2) have been thought to play a role in cyst enlargement.[17]

Present microsurgical techniques, instrumentation and neurophysiologic monitoring have made it possible to obtain resection of these tumors with good outcomes. Gamma Knife radiosurgery is an alternative having the advantages of minimal morbidity and mortality with no hospital stay. Fundova,[8] in their comparison of cystic and solid tumors, concluded that there were less favorable outcomes treating cystic tumors because of their rapid growth, early facial nerve involvement and compression of posterior fossa structures. Benech *et al.*,[4] reported higher complication rates following surgery for cystic schwannomas. Tumor fibrosis, loss of peritumoral planes with arachnoid adhesions, scarring of adjacent tissue and loss of the interface between the facial nerve and tumor make these tumors more challenging to treat with poorer clinical outcomes and recurrence rates.[24,33]

The response of vestibular schwannomas to radiosurgery varies typically from regression, and being stable or transient to possible permanent enlargement.[18,25,31] In cystic tumors, enlargement of the cystic component and neurological worsening following radiosurgical treatment are known to occur.[7] The variable growth behavior of cystic tumors and their poorer therapeutic responses have given rise to different approaches and treatment strategies to preserve neurological function and to obtain good patient outcomes.

Reports of spontaneous involution in vestibular schwannomas[27] managed conservatively during the computed tomography (CT) scan era have been described and more recent reports describe the phenomenon of tumor shrinkage and involution in a conservatively managed series.[15,16,19,21]

We report our case of an untreated vestibular schwannoma which has oscillated between periods of

growth to shrinkage well seen on MRI imaging, followed by progression. The radiological images reveal a solid tumor with centrally located small cystic areas (type C tumor) and the change in the tumor (from type C to A) between the initial diagnosis and follow-up over 3 years and subsequent to treatment. There are, however, no reports clearly documenting the oscillating growth pattern and evolution in the intrinsic cyst configuration of these tumors prior to treatment, and long-term control rates and tumor changes following treatment.

Although largely speculative, the mechanism by which a vestibular schwannoma may undergo such dramatic swings in size probably relates to the growth and rupture of its cystic components. Prior to imaging that showed a substantial reduction in the size of the tumor, the patient relates that he felt a distinct "pop" in his head in the region of the tumor. A year following GKRS, he has responded well, with no evident cysts within the tumor, along with shrinkage in size and volume of the tumor. Further follow-up over longer periods and in larger cohorts of patients is required to predict and define outcomes and treatment strategies for these tumors.

The natural history of these tumors varies in literature, and hence it becomes difficult to put forth fixed guidelines to help us manage these cases. Do oscillating tumors form a subset which may require a differing treatment paradigm? Will waiting long enough bring about an involution of the tumor or are we losing a window of opportunity in not treating the patient with radiosurgery when tumor volumes are smaller and the outcomes are better? Many surgeons would regard a >2 mm progression as an indication to treat the patient, but here we have a tumor which varied in size by almost 1 cm at different time points. Our case report emphasizes the unique nature of acoustic neuromas, requiring an individualized strategy with no "one size fits all" approach. Tumors which appear to regress also require close follow-up for a number of years before declaring involution or spontaneous resolution. In many cases, close follow-up and frequent imaging at regular intervals will dictate management on a case-by-case basis.

CONCLUSION

Although literature is replete with anecdotal reports and series of tumors shrinking, involuting or remaining stable, limited data actually exists documenting wide fluctuations and outcomes in tumor size over short periods of time. The natural history continues to remain extremely variable, and various interventions to treat these tumors have to be carefully assessed, each having their varying response rates and associated morbidity. This report clearly emphasizes the variability in the natural history of the disease and the need to weigh the treatment options, risks, benefits and outcomes.

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Commentary

The authors report a single case of a patient with an imaging-defined acoustic neuroma which varied in overall volume over the course of the observation interval and eventually underwent Gamma Knife stereotactic radiosurgery. At one year, the tumor has shown regression, and further follow-up is planned. The authors report a peculiar but occasional event in the life of an acoustic neuroma that is simply followed with serial observation. In our series of over 1500 acoustic neuroma patients who have undergone Gamma Knife radiosurgery, we have seen similar rare examples of tumors that vary in size between examinations. Fortunately, high-resolution MRI scans are able to detect volumetric changes quite well. Many thought that patients with cystic or multicystic acoustic neuromas were less likely to respond with volumetric regression after Gamma Knife radiosurgery. The opposite is actually true. Patients with such tumors almost invariably show significant tumor regression.

As the authors point out, there are a number of possible factors which lead to cystic development in an acoustic neuroma: microinfarction, hemorrhage, or radiation-related antineoplastic effects with central necrosis. I have had a single case of a patient who had enlargement of their acoustic neuroma related to an intratumoral post-radiosurgery hemorrhage. While I tempted to rush in for urgent decompression, this patient had minor symptoms despite the volumetric change. We elected observation, and to our surprise, the tumor showed dramatic regression over the course of an additional period of one year. Since approximately 2-5% of acoustic neuromas will show transient enlargement of the tumor after radiosurgery, it is important for physicians and their patients to have additional patience. Surgical approaches are needed only in those patients who have persistent, documented enlargement over the course of multiple examinations in the context of new clinical symptoms. Perhaps the only exception to this are a small group of patients who develop trigeminal neuralgia related to tumors that compress the trigeminal nerve. While most patients will be managed medically, patients with refractory trigeminal neuralgia may require tumor decompression. Since tumor growth control can be expected in more than 95% of patients, such patients should only undergo partial tumor removal with the goal of preservation of existing neurologic function.

The authors chose observation of this late 60-year-old patient with a moderate size acoustic neuroma. In my experience, patients with such tumors invariably progress within 10 years, and the growth rate is never linear. Such tumors tend to grow in steps with periods of dormancy followed by periods of activity. They all enlarge over time, and the current strategy of "just watch it," seems to be aberrant management of this tumor except in the very elderly. The authors note that their plan was within a very large number of isocenters of radiation. In my experience, the average number of isocenters to treat acoustic neuromas with Gamma Knife with high conformality is 8-10. While conformality in indices makes mathematical sense, there is very little data that such indices have clinical relevance. What is important is that volumetric radiosurgery has the tumor well defined and well planned.

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