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Cystic Vestibular Schwannoma: Classification, Management, and Facial Nerve Outcomes

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Objective: Review of postoperative morbidity and facial nerve outcomes of cystic vestibular schwannoma (CVS) patients compared with solid vestibular schwannoma (SVS) patients and a proposal for a new CVS classification system.
Study Design: Retrospective review.
Setting: Tertiary care facility.
Patients: Ninety-six patients with surgically treated CVS (1998–2008). Outcomes were assessed in a subpopulation of 57 patients with greater than or equal to 1-year follow-up compared with 57 SVS patients.
Intervention: Fifty-six CVS patients underwent the enlarged translabyrinthine approach with transapical extension (Type I), and 1 patient underwent a transcochlear/transzygomatic approach.
Main Outcome Measure: Preoperative and postoperative (at least 1 yr) House-Brackmann facial nerve (HBFN) grade evaluation.
Results: Favorable HBFN grades (I–III) were observed in 46 (81%) CVS patients, and unfavorable HBFN grades (IV–VI) were seen in 11 (19%) CVS patients. Comparison of tumor size and 1-year HBFN grades showed significant, moderate to strong, Pearson correlation (0.38). Comparison of long-term facial nerve outcomes with a sample of 57 matched SVS patients showed no significant difference ($p = 0.74$). When the tumor was adherent to the facial nerve and a dissection plane could not be developed between the cyst wall and the nerve, only subtotal resection could offer the CVS patients a normal facial nerve outcome.
Conclusion: In most CVS cases, complete resection should be foreseen. Central and thick-walled tumors can be removed in almost all cases. However, when peripheral thin-walled, adherent, cystic tumors are confronted and the cysts are medially or anteriorly located, we recommend subtotal resection, leaving portions of the cyst walls on neurovascular structures and on the facial nerve. This surgical strategy allows us to improve facial nerve outcomes and to reduce complications. **Key Words:** Acoustic neuroma—Cystic vestibular schwannoma—Facial nerve outcomes—Translabyrinthine approach—Vestibular schwannoma.
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Vestibular schwannomas account for 6 to 8% of all intracranial tumors and 80% of tumors that arise in the cerebellopontine angle (CPA) (1). These lesions can be divided into 3 groups: homogeneous, heterogeneous, and cystic. Cystic vestibular schwannomas (CVS) differ from solid schwannomas by their rapid growth, frequent involvement of facial nerve, and somewhat unpredictable biologic behavior. Cystic vestibular schwannomas have been estimated to represent anywhere from 5.7 to 48% of all vestibular schwannomas, with more recent studies in favor of numbers closer to 10% (2–5). However, the true incidence is debatable because there are various descriptions of what constitutes a CVS. (2,5–7).

Preoperatively, CVS can be identified with magnetic resonance imaging (MRI). Fluid-filled portions of these lesions seem hyperintense on T2-weighted images, whereas solid portions are isointense or hypointense with the brain on T1-weighted imaging. The solid tumor component and the cystic wall are enhanced with gadolinium (8,9) (e.g., Fig. 1B and D). Enhancement of the cyst wall is an imaging characteristic that can be used to differentiate CVS from arachnoid cysts and epidermoids (8).

In the absence of a cystic component, the growth rate for these tumors is known to range from approximately 2 to 6 mm/yr (10). Some authors think that only a limited number of solid vestibular schwannomas (SVS) grow

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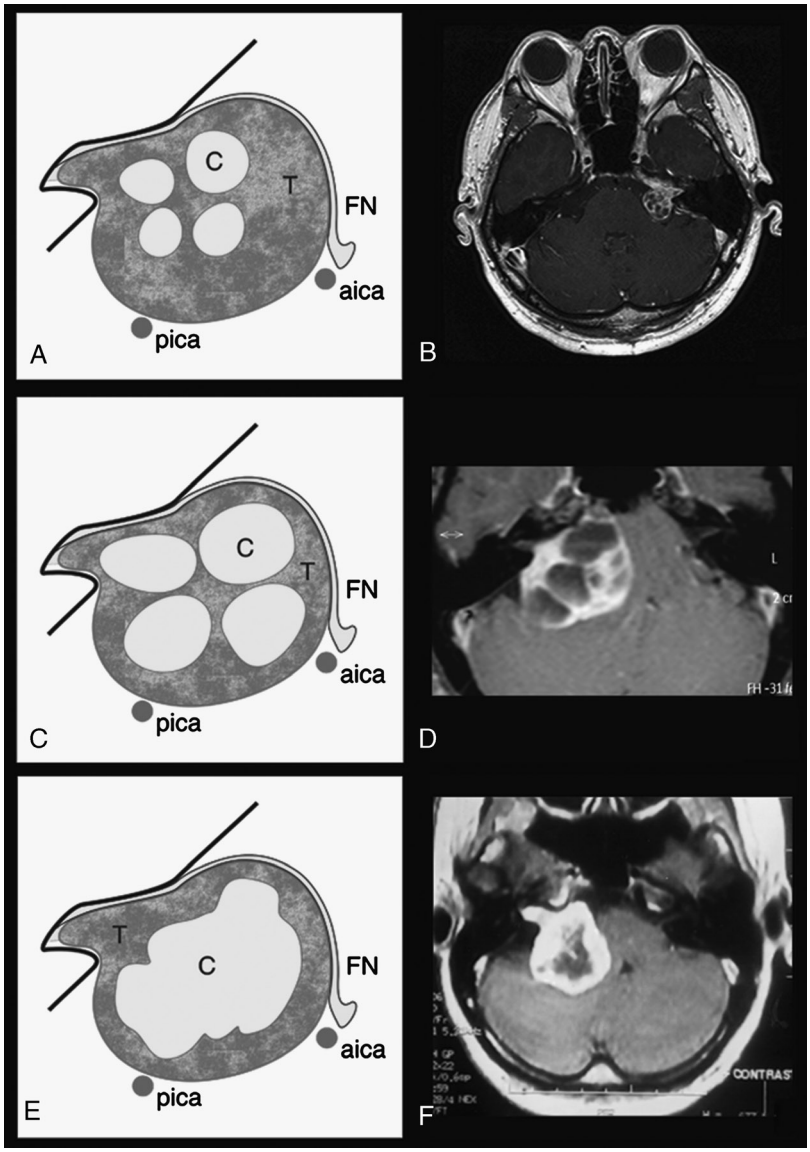

FIG. 1. Schematic illustrations and representative MRI examples of each subtype of Type A CVS according to the proposed classification in Table 1. Type A1 (*A*, *B*). Type A2 (*C*, *D*). Type A3 (*E*, *F*). Cyst (*C*), solid tumor (*T*), facial nerve (*FN*), *PICA*, and *AICA*. Images *B*, *D*, and *F* are T1-weighted axial images with contrast.

continuously (11). In the presence of a cyst, there can be rapid expansion of the lesion, brainstem compression, and hydrocephalus associated with neurologic symptoms (12). Rapid CVS enlargement can also occur as a consequence of intratumoral hemorrhage (13). In addition, cyst expansion and neurologic impairment have also

TABLE 1. *Proposed classification for CVS is first based on overall cyst location (central or peripheral) and cyst wall thickness (thick or thin)*

Type	Overall cyst location/cyst wall thickness	Subtype	Definition
A	Central and thick wall	1	Polycystic (multiple small intratumoral cysts with a thick cyst wall)
		2	Polycystic (multiple moderate size intratumoral cysts with a thick cyst wall)
		3	monocystic (single large cyst with a thick or thin cyst wall)
B	Peripheral and thin wall	1	Anterior
		2	Medial
		3	Posterior
		4	Combined

Type A lesions are further subdivided by the cyst characteristics (polycystic or monocystic) and size. Type B lesions are further classified according to cyst orientation with respect to the internal auditory meatus (anterior, medial, posterior, or a combination of these locations).

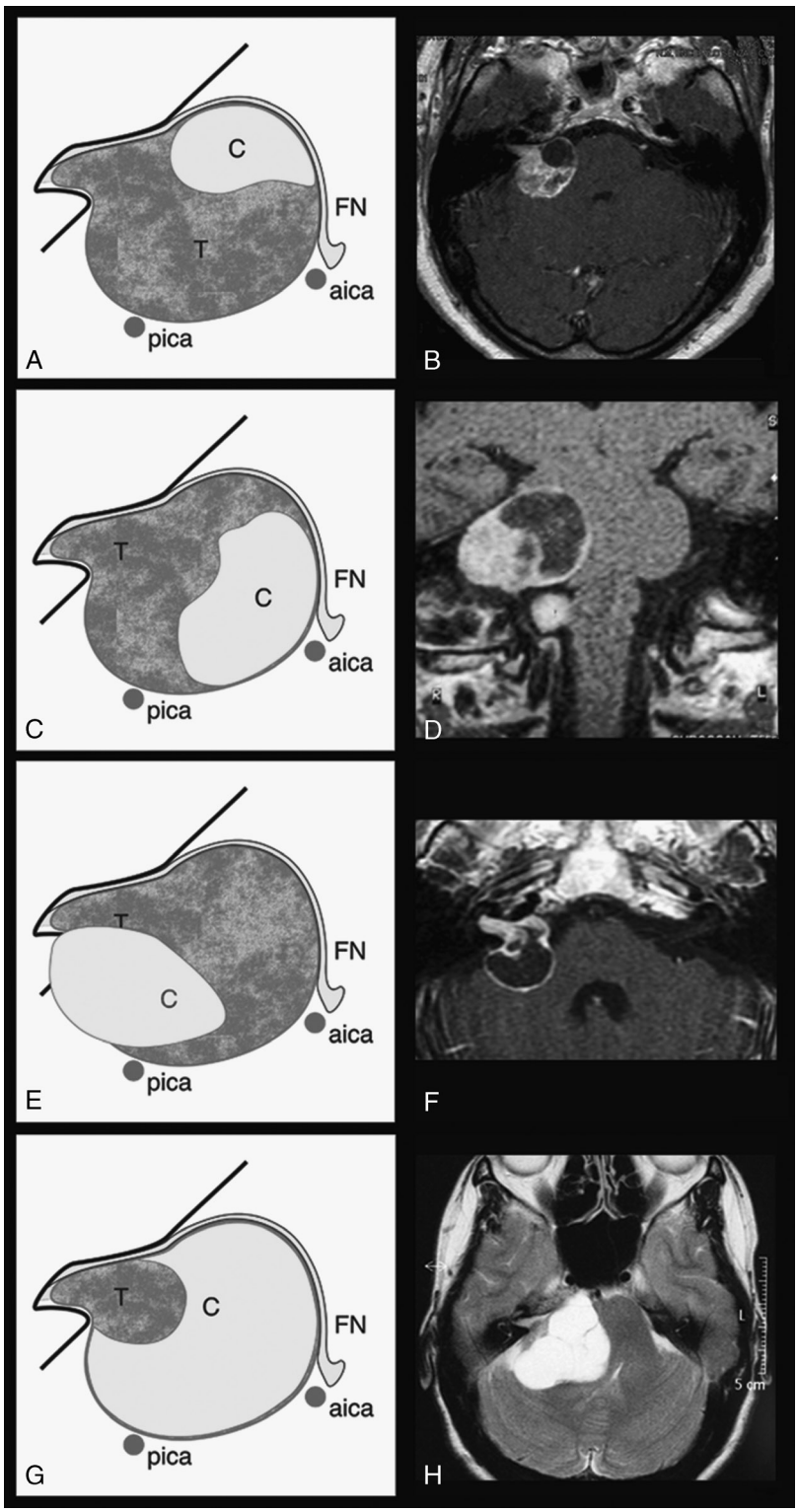

FIG. 2. Schematic illustrations and representative MRI examples of each subtype of *Type B* CVS according to the proposed classification in Table 1. Type B1 (*A*, *B*). Type B2 (*C*, *D*). Type B3 (*E*, *F*). Type B4 (*G*, *H*). Cyst (*C*), solid tumor (*T*), facial nerve (*FN*), *PICA*, and *AICA*. Magnetic resonance images *B*, *D*, and *F* are T1-weighted axial images with contrast. Magnetic resonance image *H* is a T2-weighted image.

been documented after attempted treatment with radiosurgery (12,14).

Contemporary treatment options for CVS include observation, surgery, radiosurgery via one of a number of modalities, and/or a combination of surgery and radiosurgery. Because of the unpredictable growth patterns and reported cases of cyst enlargement after radiosurgery, complete or subtotal microsurgical resection is often recommended for CVS (5,15). However, literature suggests that facial nerve outcomes after CVS resection have been less favorable in comparison to results after removal of SVS (3,5,16,17).

In this study, we present our series of surgically treated CVS. We review postoperative morbidity and facial nerve outcomes and compare these results with those from SVS resected during the same period at our institution. Finally, we propose a classification system for CVS that might be used to guide surgeons in the management of these tumors to optimize surgical results.

MATERIALS AND METHODS

We retrospectively reviewed all cases of vestibular schwannomas operated in our center between January 1998 and May 2008. Patients were included in this study if they had a CVS and were treated at our institution during this period. A tumor was labeled as a CVS if it satisfied 2 requirements: presence of hypodense/hypointense areas on MRI and intraoperative identification of cystic elements. All CVS patients treated at our institution during this period underwent surgery by the same surgeon (M.S.). Of 1,416 patients that underwent vestibular schwannoma resection during this period, we identified 96 with CVS. Fifty-seven of these CVS patients had greater than or equal to 1 year of documented follow-up. Ninety-six SVS patients were randomly selected from our vestibular schwannoma database for comparison on facial nerve outcomes, morbidity, and mortality in the following manner. To compare CVS with SVS, solid tumors were first stratified according to size and later selected through random computer assignment. Tumor size was stratified as less than 1.0, 1.1 to 2, 2.1 to 3, 3.1 to 4, and 4.1 to 5 cm. The number of SVS patients selected from each tumor size group equaled the number of CVS patients in each group.

In 1998, we began to photographically record preoperative and postoperative MRI scans and preoperative and postoperative facial nerve function of all vestibular schwannoma patients. The photographic MRI record allowed us to accurately identify patients for this study, develop a proposed classification system for CVS, and separate tumors based on this classification system. To evaluate facial nerve function, photographs were taken of patients with their face at rest, closing their eyes, raising their eyebrows, and smiling. Analysis of facial nerve results was limited to those patients with greater than or equal to 1 year of follow-up.

The following variables were recorded from each chart: patient demographics, tumor size and location, cyst position, cyst wall thickness, surgical strategy, operative findings, and complications. Preoperative and postoperative House-Brackmann facial nerve (HBFN) grade were also recorded (18). Any statistical analysis was completed using GraphPad Instat.

All patients underwent preoperative gadolinium-enhanced MRI of the brain and internal auditory canals. These images were used to determine tumor size, cyst position, and cyst wall thickness. Tumor size was measured at the largest extrameatal tumor diameter on the preoperative MRI (6). Tumors were first classified based on overall cyst location and cyst wall thickness: central and thick-walled (Type A), or peripheral and thin-walled (Type B). Type A lesions were then subdivided by cyst characteristics (polycystic or monocystic) and size. Type B lesions were classified according to cyst orientation with respect to the internal auditory meatus (anterior, medial, posterior, or a combination of these; Table 1). According to the proposed classification, schematic illustrations and representative MRI examples of each subtype of CVS are provided in Figures 1 and 2.

The amount of tumor removal during initial operation was used to divide CVS patients into 2 groups: complete or subtotal resection (>5% of tumor left; Fig. 3) (6). In cases of subtotal resection, the location of adherent remaining tumor was recorded at the time of the operation at 1 or a combination of up to 3 locations: facial nerve, brainstem and intracranial vessels (anterior inferior cerebellar artery [AICA]), posterior inferior cerebellar artery, or superior cerebellar artery. The type of resection was determined preoperatively or intraoperatively. If the operative goal was complete tumor resection and the involved portion of facial nerve was accidentally interrupted, an attempt was made at facial reanimation. This was accomplished with either an interposition nerve graft or a hypoglossofacial anastomosis (19,20). If the operative goal was subtotal

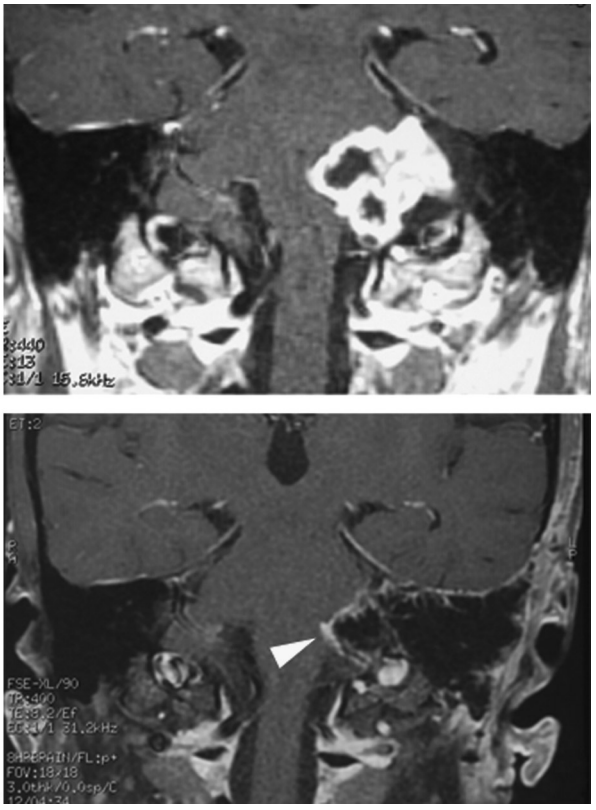

FIG. 3. Subtotal left CVS resection example on coronal and axial MRI. *A*, Preoperative coronal T1-weighted image with contrast showing left CVS. *B*, Postoperative T1-weighted image with contrast, showing subtotal resection, left cystic tumor remnant is marked with the *white arrowhead*.

TABLE 2. *Summary of all CVS patients that underwent surgery at our institution during the period from January 1998 to May 2008*

CVS patients, n			
Period	1998–2003	2004–2008	1998–2008
Patients	26	70	96
Male	12	34	46
Female	14	36	50
Right-sided tumors	13	34	47
Left-sided tumors	13	36	49
Complete resection	26	51	77
Subtotal resection	0	19	19
Nerve graft	1	8	9
Hypoglossofacial anastomosis	1	2	3
>1 yr of follow-up	16	41	57

The patients are grouped according to date of operation. After 2004, there is a tendency toward subtotal resection (to leave the cyst wall in place).

TABLE 3. *Summary of all SVS patients randomly selected from groups of patients stratified for tumor size (January 1997 to February 2007)*

SVS patients, n	
Period	1998–2008
Patients	96
Male	42
Female	54
Right-sided tumors	44
Left-sided tumors	52
Complete resection	80
Subtotal resection	16
Facial nerve graft	4
Facial nerve end-to-end anastomosis	1
Hypoglossofacial anastomosis	4
>1 yr of follow-up	96

The mean tumor size was 2.7 cm (range, 0.2–5 cm).

tumor resection, portions of the cyst wall were left in place when it was not possible to develop a dissection plane between the facial nerve, brainstem, and/or major vessels.

RESULTS

Patients

Between 1987 and May 2008, we completed 1,750 vestibular schwannoma resections. Among 1,416 patients that underwent vestibular schwannoma resection at our institution during the period ranging from January 1998 to May 2008, 96 (6.8%) patients underwent some form of CVS resection. Preoperatively, all CVS patients had normal facial nerve function. A summary of all surgically treated CVS patients from this period is provided in Table 2. This table shows patients grouped according to date of operation, demonstrating a tendency from 2004 on toward more subtotal resections.

Complications

Table 3 provides a summary of the SVS group. Postoperative complications that were identified among the group of 96 CVS patients and the 96 SVS patients are listed in Table 4. There was no mortality in either group of patients. The total percentage of all complications directly related to the schwannoma resection was only slightly greater in the CVS group (6.25%) compared with the SVS group (5.21%).

1-Year Follow-Up

Fifty-seven CVS patients had greater than or equal to 1 year of documented follow-up at our institution. The bulk of the analysis presented here is based on these 57 patients unless otherwise stated. Of the 57 CVS patients, 29 were men and 28 were women, whereas the average age was 51 years (median, 50 yr; range, 27–80 yr). Fifty-seven SVS patients with greater than or equal to 1-year follow-up were randomly selected from the group of 96 SVS, first according to CVS tumor size and later by computer assignment. Of the 57 SVS patients, 22 were men and 35 were women, whereas average age was 49 years (median, 47 yr; range, 25–79 yr).

Tumors

The average CVS size was 2.8 cm (median, 3 cm; range, 0.8–5 cm). Cystic vestibular schwannomas were grouped according to the proposed classification system presented in Table 1: Type A, 25 (44%; Type A1, 15 [26%]; Type A2, 6 [11%]; Type A3, 4 [7%]) and Type B, 32 (56%; Type B1, 3 [5%]; Type B2, 8 (14%); Type B3, 5 (9%); Type B4, 16 [28%]). Average SVS size was 2.8 cm (median, 3 cm; range, 0.8–5 cm).

Surgical Strategy

Fifty-six CVS patients underwent the enlarged translabyrinthine approach with transapical extension (Type I), and 1 patient underwent a transcochlear/transzygomatic approach (21,22). Forty-seven CVS (82%) patients underwent complete resection, whereas 10 (18%) underwent subtotal resection. Among patients that underwent complete tumor resection, 7 required interruption of the facial nerve and grafting, and 2 required hypoglossofacial anastomosis. Among patients that underwent subtotal resection, the tumor was left in contact with the facial nerve in 8 cases (2 facial nerve, 5 facial nerve and brainstem, 1 facial nerve, brainstem, and vessels). The tumor

TABLE 4. *Cystic vestibular schwannoma versus SVS complications and mortality*

Complication	CVS (n = 96)	SVS (n = 96)
Abdominal fat graft site hematoma	1	0
Cerebrospinal fluid leak	1	0
Intracranial hemorrhage	1	0
Lower cranial nerve deficit	2	1
Sigmoid sinus thrombosis with concurrent ipsilateral vision loss	0	1
Sixth nerve palsy	1	1
Subdural hematoma	0	2
Transient ischemic attack	1	0
Mortality	0	0
Total complications directly related to the schwannoma resection, n (%)	6 (6.25)	5 (5.21)

TABLE 5. *57 CVS patients with greater than or equal to 1-yr follow-up grouped by HBFN*

HBFN	n	%	Mean tumor size, cm
I	15	26	2.3
II	4	7	2.9
III	27	47	2.7
IV	6	11	3.9
V	4	7	3.8
VI	1	2	2.0
Total	57	100	

The number of patients (n), percentage of the total (%), and mean tumor size for each group are shown.

was left in contact in 1 case with the brainstem and in another with the intracranial vessels.

All 57 SVS patients underwent the enlarged translabyrinthine approach with transapical extension (Type I). Forty-eight (84%) SVS patients underwent complete resection, and 9 (16%) underwent subtotal resection. Among the SVS patients that underwent complete resection, none required nerve grafting, whereas 2 required hypoglossofacial anastomosis. One SVS patient underwent subtotal resection and required hypoglossofacial anastomosis.

Facial Nerve Outcomes

Among the 57 CVS patients with greater than or equal to 1 year of follow-up, favorable (Grades I–III) HBFN grades were observed in 46 (81%) CVS patients, and unfavorable (Grades IV–VI) HBFN grades were found in 11 (19%). These patients were further grouped by HBFN grade in Table 5 and Figure 4. Twenty CVS patients (80%) with Type A tumors had favorable outcomes, and 5 (20%) had unfavorable facial nerve outcomes. Twenty-six CVS patients (81%) with Type B tumors had favorable outcomes, and 6 (19%) had unfavorable facial nerve outcomes. A comparison of tumor size and 1-year facial nerve follow-up grades showed a significant, moderate to strong Pearson correlation (0.38). The long-term facial nerve outcomes from the sample of 57 CVS patients were compared with a sample of 57 matched SVS patients through Wilcox matched-pairs signed-ranks test. This test showed no significant difference in long-term facial nerve outcomes between these 2 groups ($p = 0.74$). This comparison is further demonstrated in Figure 5.

Furthermore, we compared the CVS facial nerve outcomes after complete resection with facial nerve reanimation (nerve graft or hypoglossofacial anastomosis) and subtotal resection. When the tumor was adherent to the facial nerve, not a single case in the complete resection group had a facial nerve outcome better than Grade III, and normal facial nerve function was only achieved after subtotal resection.

2-Year Follow-Up

Of the 96 CVS patients included in this study, 19 had greater than or equal to 2 years of documented follow-up at our institution. Of those 19 patients, 3 underwent subtotal resection, 1 of which developed a recurrence that required reoperation. The patient was a 60-year-old man with a 2.5-cm (Type B4) CVS. In March 2006, he underwent a translabyrinthine approach for resection of this lesion. Intraoperatively, significant bleeding developed that required additional retrosigmoid access for control. The surgeon ended the procedure prematurely due to blood loss. A small portion of solid tumor was left at the internal auditory meatus along the facial nerve, and a portion of the cyst wall was left attached to the brainstem. Postoperatively, his facial nerve function recovered to normal. An MRI showed no evidence of tumor regrowth 7 months after operation. Approximately 30 months after the operation, he returned to our institution with Grade III facial paralysis. Follow-up MRI showed regrowth of the residual tumor that seemed almost identical to the first lesion except for a more anterior location of the cystic component in the CPA. He underwent a transotic approach and subtotal resection of the recurrent CVS 31 months after his first operation. Thus far, he has done well postoperatively.

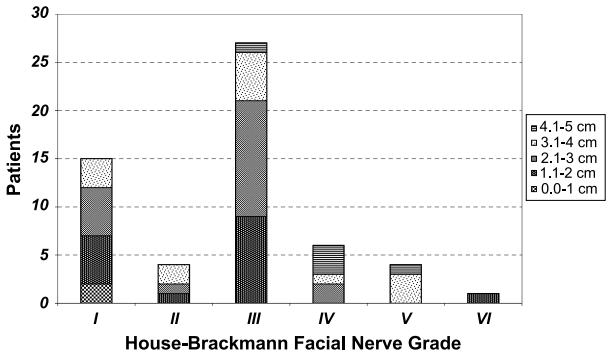

FIG. 4. Facial nerve outcomes in CVS patients with greater than or equal to 1 year of follow-up. Cystic vestibular schwannoma patients are separated into groups according to their 1-year HBFN outcome. Each column is further divide by tumor size.

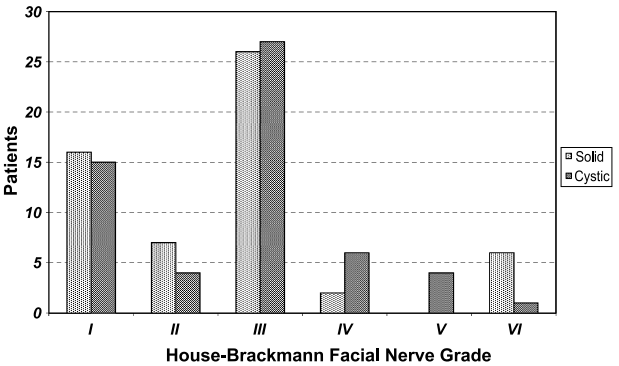

FIG. 5. Long-term facial nerve outcomes and tumor type. Facial nerve grades from 57 patients that had solid tumors are compared with 57 patients that had cystic tumors.

DISCUSSION

Cystic vestibular schwannomas are widely described as being more aggressive, having shorter symptomatic periods before presentation, poorer responses to radiosurgery, and worse outcomes from surgical intervention (3,5,15,16,23,24). Factors that lead to unfavorable surgical outcomes include engulfment of and adherence to neurovascular structures, hypervascular solid portions of the tumor, and the absence of an adequate subarachnoid dissection plane. Although each of these elements can be encountered during surgical removal of SVS, it seems they occur with increased frequency during resection of CVS. In large published series, they are typically only alluded to because they cannot be analyzed in a systematic, objective way. Analysis is further complicated because there are various descriptions of CVS, and there is a lack of a universal classification system for these tumors.

Fundova et al. (5), Yamakami et al. (7), Kameyama et al. (24), and Shirato et al. (25) have offered descriptions and/or classification systems for CVS. To facilitate clinical studies, a consensus meeting was held to discuss the reporting vestibular schwannoma results in 2003. It was recommended that multicystic tumors be identified as a separate group when reporting results. Tumors included in this group are those in which the cystic components are on the tumor's surface (6). To assist with preoperative surgical planning and to standardize the reports of surgical results, we propose a simple classification system based on preoperative imaging confirmed with intraoperative findings (Table 1, Figs. 1 and 2).

The pathogenesis leading CVS formation is unknown. Theoretically, CVS could form because of 1 or a combination of the following mechanisms: tumor growth and subsequent central necrosis, coalescence of microcysts formed in Antoni B tissue, and/or repeated intratumoral hemorrhage (26,27). Later, gradual cyst enlargement could be attributed to osmotic gradients set up by extravasation of serum proteins from an impaired blood-tumor barrier and/or the production of mucinous material within the cyst (3,26). Recently, high levels of proteolytic enzymes (matrix metalloproteinase 2) have been identified in CVS fluid and cyst walls. These enzymes are thought to play a role in cyst formation and enlargement in other cystic diseases. It has been inferred that these enzymes may play an important role in the pathogenesis of cyst formation and peritumoral adhesion in CVS (17).

Fundova et al. (5) conducted a comparison of CVS and SVS. Their study showed that patients with CVS had a significantly shorter initial duration of symptoms and worse facial nerve outcomes. However, CVS were subjectively evaluated to be "less" adherent to intracranial structures (brainstem, trigeminal nerve, lower cranial nerves, and dura, with no mention of adherence to the facial nerve) than SVS. They surmised that the less favorable surgical outcomes seen with CVS were due to rapid tumor growth and compression of posterior fossa structures. In contrast, Moon et al. (17) reported significantly increased adherence of cystic tumors to the facial nerve. Benech et al. (15) also reported increased adherence to neural structures with increased complications related to dissection of adhesions from the brainstem.

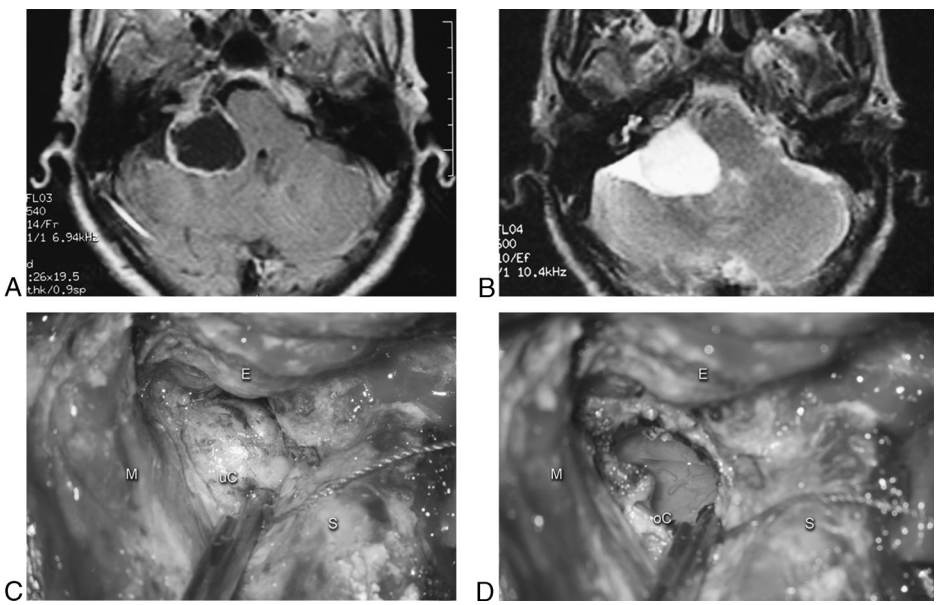

FIG. 6. Right Type B4 CVS that was recently operated at our institution through a translabyrinthine approach. *A*, Preoperative axial T1-weighted image with contrast showing a right CVS. *B*, Preoperative axial T2-weighted image of the same lesion. *C*, Intraoperative photograph showing the unopened CVS (*uC*) through a translabyrinthine approach. *D*, Intraoperative photograph showing the opened CVS (*oC*). The vessels lying between the thin cyst wall and the brainstem were visible (*D*). Middle fossa dura (*M*), boney external auditory canal (*E*), and sigmoid sinus (*S*).

In most studies, reported facial nerve outcomes after CVS resection have been less favorable in comparison to results after removal of SVS (Table 5) (3,5,16,17,23,28). Benech et al. (15) showed a trend toward worse facial nerve outcomes after CVS resection in comparison to solid tumors that did not reach statistical significance. However, Jones et al. (2) found no significant difference in facial nerve outcomes when they compared their series of CVS and SVS.

Our comparison of long-term facial nerve outcomes from 57 CVS patients and 57 matched SVS patients showed no significant difference. However, we think CVS are more adherent to neurovascular structures, and we attribute the similar facial nerve outcomes to familiarity with the intraoperative management of CVS, using subtotal resection when necessary and overall surgical experience. We agree with Samii et al. (29) that the predictive factors for facial nerve preservation include not only tumor size and extension, cystic tumor consistency, previous surgery, or radiosurgery, but also a surgeon's operative experience.

Vascular complications constitute a relatively rare but significant problem seen after resection of vestibular schwannomas. Hegarty et al. (30) reported a 2.1% rate of distal AICA territory infarcts. Samii and Matthies (23) reported an overall rate of symptomatic postoperative hemorrhage of 2.2%. Sade et al. (31) reported a 2.7% rate of vascular complications in their series of 391 vestibular schwannomas. We reported a hemorrhagic complication rate of 1.3% without analysis of solid versus cystic tumors in a series of 707 patients (32). In our present series, 1 patient (~1%) had a transient ischemic attack on postoperative Day 4, and 1 patient (~1%) developed postoperative intracranial hemorrhage that required surgical intervention.

In 2004, we reported the surgical volume of vestibular schwannoma resected at our institution between 1987 and 2001 (32). In the current study, we found that 6.8% of surgically treated vestibular schwannoma patients had CVS. Using this percentage to estimate the number, we think an additional 23 CVS patients were treated at our institution in the 10 years before 1998. Therefore, based on senior authors' experience of 119 CVS, the following recommendations are made.

Three factors need to be considered before CVS resection: thickness of the cyst wall, position of the cyst, and extrameatal size of the lesion, including cystic and solid components. In the senior authors' experience, vestibular schwannomas with centrally located cysts and thick cyst walls or tumors with intratumoral cystic change (both Type A) tend to be less difficult to remove.

Thin-walled, Type B tumors can present a more formidable challenge. Subtotal resection is frequently warranted when tumors of this nature are encountered. Figure 6 is an example of a thin-walled Type B CVS that was recently operated at our institution. Preoperative axial MRI images and intraoperative photographs demonstrate the degree of tumor adherence to the brainstem. In this case, the vessels lying between the thin cyst wall and brainstem were visible (Fig. 6D). Unable to develop an adequate subarachnoid plane, the surgeon left a portion of the cyst wall in place. There was no immediate postoperative morbidity.

Although many important neurovascular structures are encountered during the resection of any lesion in the CPA, to simplify the resection of CVS, we recommend that surgeons focus their attention on the brainstem, the facial nerve, and the vessels in the posterior fossa. One should correlate cyst position with these structures and attempt to preoperatively plan their management of the tumor. For example, with anteriorly based cysts, one should consider subtotal removal leaving the capsule on the facial nerve. When medially or posteromedially based cysts are confronted, especially when that brainstem and the 4th ventricle are compressed, complete resection can be difficult. In these situations, consideration should be given to leaving a portion of the cyst wall on the brainstem and vital vessels. On the other hand, purely posterior cysts are typically less difficult to remove, and complete resection is often achieved. Careful dissection along the surface of the cerebellum is typically inconsequential.

We recommend looking for subarachnoid planes that lend themselves to blunt or sharp dissection. In addition to these conventional dissection methods, we have had success using a bipolar to detach the cyst wall. When activated at a safe distance from vital neurovascular structures, the bipolar current can spread across the surface of the cyst and begin to develop a subarachnoid plane. If the cyst wall is thin, lying over the facial nerve, the brainstem or vessels of the posterior fossa, we advocate subtotal resection in these areas, leaving portions of the cyst wall.

Finally, during the resection of any CVS, surgeons need to pay particular attention to the depth of their dissection because it is possible to pass through the cyst and unintentionally enter normal brainstem parenchyma. This is a crucial point in the resection of polycystic tumors due to the multiple layers of tissue that the surgeon encounters.

CONCLUSION

In most cystic vestibular scwhannomas, complete resection should be foreseen. Central and thick-walled tumors can be removed in almost all cases. However, when peripheral thin-walled, adherent, cystic tumors are confronted and the cysts are medially or anteriorly located, we recommend subtotal resection, leaving portions of the cyst walls on neurovascular structures and on the facial nerve. This surgical strategy allows us to improve facial nerve outcomes and to reduce complications.

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