Analysis of taste disturbance before and after surgery in patients with vestibular schwannoma

KATSUSHI WATANABE, M.D., PH.D., NOBUHITO SAITO, M.D., PH.D., MAKOTO TANIGUCHI, M.D., PH.D., TAKAAKI KIRINO, M.D., PH.D., AND TOMIO SASAKI, M.D., PH.D.

Department of Neurosurgery, Faculty of Medicine, Gunma University, Maebashi; Department of Neurosurgery, Tokyo Metropolitan Neurological Hospital, Fuchu; Department of Neurosurgery, Faculty of Medicine, University of Tokyo; and Department of Neurosurgery, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan

Object. The frequency, nature, and history of subjective taste disturbance before and after vestibular schwannoma (VS) surgery was investigated.

Methods. Personal interviews were conducted in 108 patients with unilateral VS. Abnormalities in taste perception, either a significant reduction or a change in character, were experienced by 31 patients (28.7%) before surgery and by 37 (34.3%) after tumor removal. Preoperative taste disturbance worsened after surgery in five (16.1%) of the 31 patients, remained unchanged in eight (25.8%), improved in two (6.5%), and became normal in 16 (51.6%). Taste disturbance occurred postoperatively in 22 (28.6%) of 77 patients who had experienced no preoperative taste disturbance. The mean onset of the abnormality after resection was 1.1 ± 1.7 months. Postoperative taste disturbance resolved in 24 of the 37 patients (64.9%) within 1 year after onset.

Conclusions. Subjective taste disturbance was common before and after VS removal, and the natural history of this condition was very variable in the pre- and postoperative periods. All patients who undergo surgery for VS should receive appropriate counseling about the likelihood and course of postoperative complications, including dysfunction of the sensory component of the facial nerve.

KEY WORDS • vestibular schwannoma • acoustic neuroma • taste disturbance • intermediate nerve • resection

Facial weakness is perhaps the most devastating sequela after resection of VSs because it can be both physically and psychologically disabling for the patient. Thus, it is not surprising that the overwhelming majority of the literature on facial nerve outcome after VS surgery focuses on the motor component of the nerve, and almost ignores its sensory component, which reflects the recent increased interest in the postsurgical quality of life. The perspective of the surgeon may be different from that of the patient, however. In particular, it is interesting to note that patients exhibit more disturbances linked to the sensory component of the facial nerve.

The intermediate nerve, which is the sensory component of the facial nerve, has a close anatomical association with the facial nerve motor fibers in the cerebellopontine angle. Consequently, these fibers are at risk for injury during VS surgery. The intermediate nerve contains the special sensory (taste) fibers originating from the taste buds of the anterior two thirds of the tongue as well as the preganglionic parasympathetic secretomotor fibers that innervate the lacrimal gland, nasal and palatine mucous glands, and submandibular sublingual salivary glands.

Abnormalities of the nonmotor component of the facial nerve are less obvious to the surgeon. Nonetheless, dysfunctional taste sensation can deprive the patient of any enjoyment of food, one of the great pleasures and motivations of human life. The incidence of taste abnormalities before and after VS surgery and the natural history of taste disturbance remains unclear. Quantitative analysis of taste function by performing electrical gustometry before and after surgery has also been little studied.

In this study we evaluated taste abnormalities in patients who had undergone VS surgery, to allow better counseling of such patients about the likelihood and course of this complication.

Clinical Material and Methods

Patient Population

Two hundred consecutive patients underwent surgery for excision of VS performed by the same surgeon (T.S.) between 1992 and 2002. Our review identified 108 patients, 48 men and 60 women between the ages of 25 and 74 years (mean 48 ± 12 years), who could be interviewed by our group to evaluate taste function before and after surgery. Patients were asked to assess their taste functions subjectively. Their charts, including electrophysiological data and follow-up clinic notes, were carefully reviewed. The follow-up period was at least 1 year in all patients, with a maximum follow up of 5 years and a mean of 1.8 years. Patients with neurofibromatosis Type 2 were excluded from the
study, so that all registered patients had unilateral VSs. The lateral suboccipital approach was performed in all cases.

Fifty-six patients had a left-sided VS and 52 had a rightsided lesion. Facial nerve motor function was assessed preoperatively and 1 year postoperatively by using the House-Brackmann facial nerve outcome scale. Tumor size was measured as the extracanalicular portion of the lesion on magnetic resonance images before surgery. Thirty tumors were 2 cm or smaller, 59 were 2.1 to 4 cm, and 19 were larger than 4 cm. Total removal of the tumor was achieved in 55 patients, subtotal (95%) in 47, and partial in six, as demonstrated by the intraoperative findings and on postoperative neuroimaging.

Electrogustometry Studies

Electrogustometry was used to evaluate the taste threshold in the bilateral controlling nerves (the chorda tympani nerves) in the 44 most recently treated patients. The taste threshold was assessed preoperatively and 1 year postsurgery. The difference in the threshold values between the left and right side was calculated. The threshold difference was compared between patients with subjective taste disturbance and those without taste disturbance before surgery and at 1 year postsurgery. The electrogustometer (model TR-06; Rion Inc., Tokyo, Japan) was equipped with a direct-current, stainless-steel electrode with a diameter of 5 mm for anodal stimulation; the amount of stimulation was expressed in decibel units. When the tongue is stimulated by direct current from the anode, a metallic or sour taste is perceived. The minimum decibel value for perception of this taste was recorded as the electrogustometric threshold. For processing, 36 dB was regarded as exceeding the electrogustometric threshold, because the maximum output of this device is 34 dB and the variable step is 2 dB. All applied methods of electrogustometry followed the protocol of Tomita, et al.19

Statistical Analysis

Data are presented as the means ± standard deviation. Groups were statistically compared using the Student t-test for continuous variables and the chi-square test for proportions. The Kruskal–Wallis test was applied for nonparametric data. Statistical significance was accepted at probability values of less than 0.05.

Results

Incidence and Character of Taste Disturbance Before and After Surgery

Abnormality in taste perception, either a significant reduction or a change in character, was experienced by 31 (28.7%) of the patients before surgery and by 37 (34.3%) at 1 year after tumor removal (Table 1), but the increase was not significant (p > 0.05, chi-square test). There was no mention of swallowing difficulty before or after surgery, and lower cranial nerve function was demonstrated to be normal on otolaryngological examination. More female pa-

\[ \text{Fig. 1. Bar graph showing the natural history of the preoperative taste function in the postoperative period. Each bar illustrates the frequency of the postoperative taste disturbance in patients with (taste dist. [+]) and without (taste dist. [−]) preoperative symptoms. Postoperative taste disturbance was classified into four categories: 1) deterioration; 2) no change; 3) improvement compared with the preoperative condition; and 4) absence of taste disturbance (normal function). N = number of patients.} \]

\[ \text{Fig. 2. Histogram showing the onset time of taste disturbance.} \]
tients tended to experience taste disturbance than males in both the pre- and postoperative periods, but without statistical significance in either period (p > 0.05, chi-square test).

The number of patients with taste disturbance increased only slightly after surgery compared with before surgery (from 28.7 to 34.3%), but the character of the disturbance was quite different. We classified the postoperative taste disturbance into four categories: 1) deterioration; 2) no change; 3) improvement compared with the preoperative condition; and 4) absence of taste disturbance (normal function). These categories were based on subjective assessment of the taste symptoms by the patients. As depicted in Fig. 1, of the 31 patients with preoperative taste disturbance, deterioration was reported in five patients (16.1%), no change in eight (25.8%), improvement in two (6.5%), and normal function in 16 (51.6%). In addition, 22 (28.6%) of the 77 patients with no preoperative taste disturbance reported worsening symptoms after surgery.

**Onset and Duration of Taste Disturbance**

As shown in Fig. 2, 15 of the 37 patients with postoperative taste disturbance also had preoperative subjective symptoms, and the other 22 suffered onset of taste disturbance after 0 to 6 months (mean 1.1 ± 1.7 months).

The duration of postoperative taste disturbance showed a fluctuating distribution; the duration was calculated from the date of operation for the patients with preoperative taste disturbance. The taste disturbance subsided within 6 months after its onset in 16 patients (43.2%), between 7 and 10 months in two (5.4%) and at approximately 12 months in six (16.3%), but continued in the 13 other patients (35.1%) for more than 12 months. Therefore, 13 (12%) of 108 patients who underwent tumor removal still had subjective taste disturbance 1 year post surgery.

**Relationship of Taste Disturbance With Extent of Resection and Facial Nerve Function**

The intermediate fibers of the nerve within the cerebellopontine angle are closely associated with the facial nerve motor fibers and are thus equally exposed to trauma during VS surgery. Therefore, we examined whether taste disturbance was correlated with the facial nerve motor function before and 1 year after surgery, and whether taste disturbance 1 year postsurgery was correlated with the extent of tumor resection in all 108 patients. The relationship between the presence of subjective taste disturbance and facial motor function in the pre- and postoperative periods is given in Table 2; there was no significant correlation at either time point (p > 0.05, Kruskal–Wallis test). The relationship between the presence of subjective taste disturbance at 1 year postoperatively and the extent of resection is given in Table 3. There was no significant correlation between the presence of taste disturbance and the extent of resection (p > 0.05, Kruskal–Wallis test). We also examined the correlation of taste disturbance before surgery with preoperative tumor size in all 108 patients (Table 4); there was no significant correlation (p > 0.05, Kruskal–Wallis test).

**Electrogustometry Findings**

Subjective taste disturbance before surgery was reported in 11 of the 44 patients tested using electrogustometry, and in seven patients at 1 year post surgery. The thresholds on the side of surgery were higher than those on the contralateral side in all patients. Figure 3 shows the wide variation in the differences in threshold in patients with and without taste disturbance in the pre- and postoperative periods. The mean threshold difference in patients with preoperative taste disturbance was 8.5 ± 9 dB (11 patients), which was higher than the 2.9 ± 4.1 dB (33 patients) found in patients without this condition, although the difference was not statistically significant (p > 0.05, Student t-test). In contrast, the mean threshold difference in patients with postoperative taste disturbance was 17.8 ± 8.5 dB (seven patients), which was significantly higher (p < 0.05, Student t-test) than the 3.8 ± 6.2 dB (37 patients) found in those without taste disturbance at 1 year postsurgery. On the other hand, the mean threshold on the contralateral side in seven patients with postoperative taste disturbance at 1 year postsurgery did not change significantly between the preoperative (3.6 ± 4.7 dB) and postoperative (4 ± 5.6 dB) periods (p > 0.05, Student t-test). Although preoperative complaints about taste disturbance did not directly correspond to electrically confirmed hypoguesia, postoperative electrically confirmed hypoguesia nearly reflected the clinical findings of taste abnormality.

**Table 2**

<table>
<thead>
<tr>
<th>HB Grade</th>
<th>W/Taste Dist</th>
<th>W/O Taste Dist</th>
<th>W/Taste Dist</th>
<th>W/O Taste Dist</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>25</td>
<td>70</td>
<td>26</td>
<td>54</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>III</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>IV</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>V</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Facial nerve function was categorized according to the House–Brackmann scale. Abbreviation: HB = House–Brackmann.

**Table 3**

<table>
<thead>
<tr>
<th>Resection</th>
<th>W/Taste Dist</th>
<th>W/O Taste Dist</th>
</tr>
</thead>
<tbody>
<tr>
<td>total</td>
<td>18</td>
<td>37</td>
</tr>
<tr>
<td>subtotal</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>partial</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

tumor resection in 108 patients. The relationship between the presence of subjective taste disturbance and facial motor function in the pre- and postoperative periods is given in Table 2; there was no significant correlation at either time point (p > 0.05, Kruskal–Wallis test). The relationship between the presence of subjective taste disturbance at 1 year postoperatively and the extent of resection is given in Table 3. There was no significant correlation between the presence of taste disturbance and the extent of resection (p > 0.05, Kruskal–Wallis test). We also examined the correlation of taste disturbance before surgery with preoperative tumor size in all 108 patients (Table 4); there was no significant correlation (p > 0.05, Kruskal–Wallis test).

**Table 4**

<table>
<thead>
<tr>
<th>Tumor Size (cm)</th>
<th>W/Taste Dist</th>
<th>W/O Taste Dist</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>2.1–4</td>
<td>16</td>
<td>43</td>
</tr>
<tr>
<td>4</td>
<td>9</td>
<td>10</td>
</tr>
</tbody>
</table>
Changes in Taste Sensation Before and After Surgery

Although there was only a slight increase in taste disturbance after surgery, its character was very different. Patients with preoperative taste disturbance had a fifty–fifty chance of experiencing postoperative taste disturbance. On the other hand, approximately 30% of patients without preoperative taste disturbance suffered postoperative symptoms in our series.

Postoperative taste disturbance subsided within 6 months of onset in 16 and within 1 year in 24 of the 37 patients, presumably as a result of both adaptation and neural regeneration. Nevertheless, the disturbance continued for more than 1 year in the remaining 13 patients.

These findings indicate the need for more specific counseling for patients before and after surgery about the likelihood and course of taste abnormalities. Presence of dysfunction of the sensory component of the facial nerve, because of its high frequency and related morbidity, should be included in the reported outcome of VS surgery.

Limitations of Electrogustometry Findings

The electrical threshold difference in patients with subjective preoperative taste disturbance tended to be higher than in those without this condition, and the difference became more prominent and statistically significant in patients with postoperative taste disturbance. This result may indicate that the intermediate nerve in patients with postoperative taste disturbance was more severely injured during the operation, compared with the nerve in patients without taste disturbance. Therefore, postoperative taste function may partly depend on the handling of the facial nerve, including the intermediate nerve, during the operation. Our findings suggest that the presence of taste disturbance has no relationship with the preoperative tumor size and the extent of resection (Tables 2 and 3). Nevertheless, the intermediate nerve is difficult to find and identify by intraoperative visual inspection, and there is no way currently to examine the function of the nerve intraoperatively.

The mean threshold difference was 8.5 ± 9 and 2.9 ± 4.1 dB in the patients with and without preoperative taste disturbance, respectively, and 17.8 ± 8.5 and 3.8 ± 6.2 dB in patients with and without postoperative taste disturbance, respectively. A difference of 6 dB or more in the electrogustometric threshold can be considered abnormal. The results in our series were consistent with this criterion.

Nevertheless, the patients without preoperative or postoperative taste disturbance also showed large variations of difference in the electrical threshold, even in threshold differences substantially greater than 6 dB (Fig. 3). In such cases, damage to the intermediate nerve was not clinically associated with significant taste reduction, and overall taste perception changed little. These findings have been confirmed in studies of the effect of damage to the chorda tympani nerve, which arises from the intermediate nerve. Approximately 20% of 126 patients with unilateral and 32 patients with bilateral chorda tympani nerve section reported no symptoms at all of taste disturbance. After bilateral resection, some of the patients noticed a taste sensation just before swallowing, when the food reached the back of the tongue. Because VS surgery may damage the intermediate nerve, patients might experience changes similar to those seen after sectioning of the chorda tympani nerve.

Phantom Sensation of Taste

After the operation, several patients reported phantom taste sensation in the empty mouth on the side of the tongue ipsilateral to the surgery. Therefore, 12 patients in whom subjective taste disturbance was found (of the 44 patients most recently tested) were interviewed about the phantom sensation of taste after surgery. The phantom sensation was reported by nine (75%) of these 12 patients. A phantom sensation of bitterness was found in eight patients, of sweetness in three, and of saltiness in three.

Discussion

Incidence of Subjective Taste Disturbance

Taste disturbance in this study includes loss, reduction, change in character, and phantom sensation of the taste, as assessed subjectively by the patients. Therefore, taste disturbance is common not only in the preoperative period (28.7% of our patients) but also in the postoperative period (34.3%).

The intermediate nerve is located at the site of contact of the expanding tumor. This nerve is also immediately adjacent to the plane of dissection created during tumor removal. The intermediate nerve between the brainstem and porous acusticus has no epineurium or perineurium and is sheathed only by a thin arachnoid membrane. Normal intermediate nerve contains 20% unmyelinated fibers. Therefore, the sensory nerve fibers have less protection from mechanical trauma than the motor fibers. Consequently, taste disturbance was commonly experienced even in patients whose postoperative facial motor function was only House and Brackmann Grade I in this series. The tumor site, surgical trauma, and minimal fiber protection all combine to expose the sensory component of the facial nerve to damage, so the high incidence of pre- and postoperative taste disturbance is hardly surprising.
Taste disturbance in vestibular schwannoma surgery

Localized loss of taste in the setting of unchanged whole-mouth taste sensation may be explained by release of inhibition to compensate for the lost nerve function. The perception of taste is derived from the interaction of the paired facial, glossopharyngeal, and, to a lesser extent, vagal nerves. As suggested by Kveton and Bartoshuk, precise clinical examination of patients who underwent VS surgery indicated that “... the glossopharyngeal nerve is normally inhibited by the facial nerve in the taste network. When the facial nerve is damaged, this inhibition is abolished. This release of inhibition served as a compensation mechanism that preserves normal taste experience.”

Phantom Sensation of Taste

Nine of twelve patients with postoperative taste disturbance experienced phantom taste sensations. The mechanism of this phenomenon presumably resulted from some form of stimulation of the injured nerve (facial nerve), the so-called “nerve-stimulation” phantom. In addition, both aberrant regeneration (redirecinting innervation) and transaxonal (ephaptic) transmission, both of which predispose the nerves to lateral spread and activation of neighboring fibers, may also be involved in the pathogenesis of this condition.

Conclusions

Taste disturbance is common before and after VS surgery. The natural history of taste disturbance is quite varied, especially when the preoperative and postoperative taste functions are compared. We suggest that appropriate counseling be given to all patients who undergo such surgery and that the surgical team should pay attention to the sensory as well as the motor component of facial nerve function.

References


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Address reprint requests to: Katsuhide Watanabe, M.D., Ph.D., Department of Anatomy and Neurobiology, College of Medicine, The University of Tennessee at Memphis, 855 Monroe Avenue, Memphis, Tennessee 38163. email: katsuwatanabe-msu@umin.ac.jp