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Original Article

Taste dysfunction in vestibular schwannomas

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Background: Gustatory dysfunction associated with vestibular schwannomas (VS) is a poorly represented clinical presentation. **Materials and Methods:** One hundred and forty-nine cases operated from 1997 to 2005 where at least six-month follow-up was available were included. All patients were tested for taste sensations using four modalities of standard taste solutions. Apart from the taste sensations, any altered or abnormal taste perceptions were recorded both in the preoperative and postoperative period. **Results:** After applying the exclusion criteria, the taste dysfunction was studied in 142 patients. The evidence of decreased taste sensation was found in 58 (40.8%) patients prior to surgery. Preoperatively, taste disturbance was found in 29 (37.2%) giant, 28 (45.9%) large and one (33.3%) medium-sized tumors, respectively. There were no significant age or sex-related differences. The postoperative taste disturbances were found in 65 (45.8%) patients. Among patients with anatomically preserved facial nerve, postoperative taste disturbances were found in 55 (42.3%) patients whereas nine (6.9%) patients reported improvement in taste sensations. **Conclusions:** Taste dysfunction is common following vestibular schwannoma surgery. Patient counseling prior to surgery is necessary to avoid any distress caused by taste dysfunction. Taste dysfunction should be included in the facial nerve functional grading system while assessing outcome.

Key words: Facial nerve preservation, gustatory dysfunction, taste sensation, vestibular schwannoma

Gustatory dysfunction associated with vestibular schwannoma (VS) surgery is a well known but a poorly represented entity. Although some of the patients harboring VS do complain of decrease or loss of taste sensation, both before and after the surgical excision of tumor, this sensory part of the facial nerve dysfunction is not included in any of the facial nerve grading systems. Similarly, other forms of the nervus intermedius dysfunction like abnormal lacrimation (crocodile tears) or disordered taste perception (dygeusia) are often overlooked during the neurological examination of these patients. Some patients misinterpret the facial and lingual numbness (fifth cranial nerve dysfunction) as abnormal taste perception. Differentiation between abnormal taste perception and facial and lingual numbness requires careful evaluation during neurological examination. Taste dysfunction occasionally represents an early form of facial nerve involvement in patients with VS. Various factors such as increased age, loss of smell, smoking/tobacco chewing, drugs causing taste alterations as well as intrinsic diseases of the tongue also influence the assessment of taste in these patients.[1,3]

In this era of micro-neurosurgery for VSs, where the aim of the surgery is not only complete excision of the tumor but also the preservation of the facial as well as cochlear nerve function, it also becomes mandatory to assess the gustatory function and its outcome following surgery. In contrast to the intraoperative monitoring of the motor component of the facial nerve function, this special sensory modality cannot be tested by intraoperative methods of facial nerve stimulation. Thus, clinical testing of taste sensations both before and after surgery is the only means of assessing the outcome following surgery. Currently, there is no accepted and standardized method for an objective assessment of the taste sensations. The four basic taste solutions (sweet, salt, sour, bitter) are, therefore, clinically assessed. Physiologically, various sites on the tongue have different thresholds for each of the four modalities of taste. Although an electrogustatometer evaluates the taste threshold quantitatively using galvanic currents, it cannot test individual modalities of taste sensations.[2,3]

In this study, we have attempted to clinically assess taste dysfunction in patients undergoing surgery for VS. An attempt has also been made to correlate the outcome of taste sensation preservation with facial nerve preservation in a patient population where the majority of the tumors consisted of large or giant VS. There are very few studies assessing taste sensations available in this patient population and the majority of them show variable results regarding gustatory dysfunction.[4,5] There are only a few reports discussing the facial nerve status in VS from India.[6-9] Facial nerve preservation was not given much importance; to quote

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Ramamurthi, saving life and functions of the lower cranial nerves still forms the main goal in the majority of patients who come with large tumors.[10] In our last study we had quoted complete tumor excision in 96.5% and anatomical preservation of the facial nerve in 79.2% of patients.[11]

Materials and Methods

In this study carried out between 1997 and 2005, taste dysfunction was evaluated in patients harboring VSs. One hundred and forty-nine cases operated during this period where at least a six-month follow-up was available were evaluated. The exclusion criteria in our study were:

1. Age more than 70 years (as taste threshold in these patients is sub-optimal).
2. Patients with intrinsic diseases of the tongue with coexisting taste dysfunction.
3. Heavy smokers, tobacco chewers with sub-normal taste functions.
4. Patients receiving anti-neoplastic drugs and other medications with abnormal taste due to the adverse effects of the drugs.
5. Patients with bilateral VSs (neurofibromatosis Type 2).

The exclusion criteria led to the exclusion of seven patients from the study. Therefore, the status of taste sensations was studied in 142 patients.

An ongoing prospective protocol study on VSs is being undertaken by the department. Based on this study, the status of taste sensations is being recorded on designated proformas by senior registrars for every patient of VS undergoing surgery. The patient's history and clinical records were also reviewed with particular emphasis on the duration of loss of taste and facial nerve dysfunction noticed by the patient. The facial nerve function was graded according to the House-Brackmann (H and B) facial grade score.[12] The tumors were graded according to their size by Jackler's classification into small, medium, large and giant tumors.[13] All patients were tested for taste sensations using the four modalities of taste solutions. In order to standardize the taste solutions and to get uniform results, specific taste solutions were prepared and used afresh each time. For testing sweet sensation, sucrose solution (5 g in 10 ml distilled water); for salty sensation, common salt (5 g in 10 ml distilled water); for sour sensation, lemon juice (10 drops in 10 ml distilled water); and, for bitter sensation, crushed powdered solution of quinine sulphate tablets (300 mg tablet in 10 ml), respectively, were used. Both halves of the anterior two-thirds of the tongue in front of the circumvallate papillae were tested for taste sensations in the standard manner and the results recorded. The taste solutions were applied on the tongue using a cotton-tipped applicator. The solutions were tested in the following order: sodium chloride, sucrose, lemon juice and quinine. The order was selected to administer the pleasant solutions first leaving the bitter solution with the longest aftertaste for the last. The loci were tested on both sides of the tongue anterior to the circumvallate papillae since the chorda tympani receives taste information from the fungiform papillae on the anterior two-thirds of the tongue. The patients rinsed their mouths with tap water and then the stimulus was applied to the side of the VS. Then the same stimulus was applied to the opposite side at symmetrically the same point. The patient was asked to indicate whether or not a difference in any of the modalities of taste sensations was present. The patient's assessment of his/her taste function was subjective and the threshold and intensity of taste sensations were not rated.

Preoperatively, the data was recorded as:

1. Difference (decrease or absence) in taste sensation on the ipsilateral half of the tongue (on the side of tumor) when compared to the contralateral side.
2. Taste dysfunction or decrease in taste not present.

Even when there was decrease in one modality of taste sensation on the side ipsilateral to the tumor when compared with the non-tumor side, it was regarded as "Taste dysfunction."

In the postoperative period, the results were recorded as:

1. No change in the taste sensations from the preoperatively recorded status.
2. Taste worsened after surgery.
3. Taste improved after surgery.

The patients were followed up with taste examination at six weeks, at three months, at six months and thereafter at yearly intervals as a part of the ongoing protocol for vestibular schwannomas. The range of follow-up was from 6 to 72 months (mean 14.07 months). The statistical analysis was done using the SPSS software version 10.00 and the statistical tests employed were Chi square tests using cross tabs.

Results

There were 82 men and 60 women (n = 142) in this study with their age ranging from 17 to 68 years (mean age: 39.5 years). Forty-nine (34.5%) patients gave taste dysfunction as a presenting complaint. On neurological examination, however, the evidence of decreased taste sensation was found in 58 (40.8%) patients prior to surgery. This shows that about 6% (nine patients; all men) of patients were unaware of their existing unilateral loss of taste sensations. The mean duration of loss of taste sensation noticed by the patient was 3.43 (SD 2.63) months. On correlating the tumor size with disturbances in taste sensation, loss of taste was found in 29 (37.2%) of giant, 28 (45.9%) of large and one (33.3%)

of medium-sized tumors, respectively, before surgery [Table 1]. However, this difference was not statistically significant ($P = 0.563$). There was associated facial nerve paresis in 13 (22.4%) cases. There was no correlation between the preoperative facial nerve dysfunction and taste disturbance.

Patients in the age group less than 40 years reported taste disturbances less frequently as compared to those in the age group more than or equal to 40 years. Of the 58 patients in whom taste dysfunction was present, 33 (40.2%) were men and 25 (41.7%) women. There were no significant "age and sex differences" in taste dysfunction [Table 2].

Table 1: Correlating the tumor size (according to Jackler's classification)[7] with the gustatory dysfunction

Tumor size (according to Jackler) in millimeter (mm)	Total No. of patients	Taste dysfunction No. of patients (% in each group)
Medium 10-25 mm	3	1 (33.3)
Large 25-40 mm	61	28 (45.9)
Giant >40 mm	78	29 (37.2)
Total	142	58 (40.8)

Table 2: Correlating the age (in years) and sex with preoperative gustatory dysfunction

	Total No. of patients	Taste dysfunction No. of patients (%)
Age in years		
Age less than 40	76	29 (38.2)
Age more than 40	66	29 (43.9)
Total	142	58
Sex		
Male	82	33 (40.2)
Female	60	25 (41.7)
Total	142	58

All 142 patients were analyzed for their taste disturbances following surgery. The postoperative study included 130 patients where the facial nerve was preserved during surgery and 12 patients where the facial nerve was not preserved. Postoperative taste disturbances were found in 65 (45.8%) patients irrespective of their facial nerve dysfunction [Table 3]. Out of a total of 142 patients, 58 had preoperative taste dysfunction. Forty-three of these patients worsened in their taste status; nine patients improved; and six reported no change in taste sensations following surgery. Twenty-two new cases developed taste dysfunction following surgery.

The postoperative taste dysfunction in patients with severe grades (H and B Grades 5 or 6) of facial paresis was observed in 82.8% (n = 24) patients; with moderate grades (H and B 3 or 4) of facial paresis, in 50% (n = 29) patients; and, with mild grades (H and B Grades 1 or 2) of facial paresis, in 21.8 % (n = 12) patients [Table 3]. In patients with tumor size more than or equal to 40 mm (Giant VS), the postoperative taste disturbances were present in 62.8% (n = 49) patients as compared to 25% (n = 16) patients with medium or large-sized tumors (tumor size <40 mm) [Table 4].

Among the 130 (91.5%) patients with preserved facial nerve [that includes both patients where facial nerve was anatomically preserved as well as those with subtotal tumor resection (where the facial nerve was presumed to be preserved), postoperative taste disturbances were found in 55 (42.3%) patients. Nine (6.9%) patients reported an improvement in taste sensations [Table 5]. Of the 12 patients in whom the facial nerve was not preserved, 83.3% (n = 10) reported deterioration in taste function as compared to the preoperative status,

Table 3: Correlating the functional status of the seventh nerve with gustatory impairment at follow-up after successful excision of the vestibular schwannoma

Functional status of seventh nerve at follow-up	Total number of patients	Status of taste examination at follow-up				
		Improvement of taste sensation	No change	Deterioration		
				Total	Taste sensations worsened	Developed new taste dysfunction
Mild	55	8 (14.5)	35 (63.6)	12 (21.8)	7 (12.7)	5 (9.1)
Moderate	58	1 (0.01)	28 (48.2)	29 (50)	18 (31)	11 (18.9)
Severe	29	0	5 (17.2)	24 (82.8)	18 (62)	6 (20.7)
Total	142	9 (6.3)	68 (47.9)	65 (45.8)	43 (30.3)	22 (15.5)
P-value (Chi square tests)		0.000	0.017	0.038		

Figures in parentheses are in percentage

Table 4: Tumor size (according to Jackler's classification) versus follow-up taste involvement

Tumor size (Jackler classification)	Total	Follow-up taste involvement			
		Improvement	No change	Worsened (%)	Developed new taste dysfunction (%)
Non-giant tumors <40 mm	64	8	40	10 (15.6)	6 (9.4)
Giant tumors >40 mm	78	1	28	33 (42.3)	16 (20.5)
Total	142	9	68	43 (30.3)	22 (15.5)
P-value (Chi square tests)		0.000	0.017	0.038	

whereas two (16.7%) patients reported no change in taste function [Table 5].

Discussion

The clinical evaluation of taste dysfunction in patients harboring VSs led to interesting findings. Fifty-eight of the 142 patients included in the study had unilateral taste impairment even in the preoperative period. This indicates the importance of evaluation of this often-overlooked clinical presentation in every patient with VS who is planned for surgical decompression. Nine patients were unaware of their existing unilateral gustatory impairment and only a specific neurological examination revealed the deficit. All of these patients were men. As has often been pointed out, women are more sensitive to gustatory perception and this factor may be responsible for the unawareness of the existing taste impairment in these male patients. In our study, only 13 patients with taste impairment had a coexisting motor seventh nerve paresis. As sensory components of cranial nerves are more sensitive to compression and their deficits appear much earlier than motor deficits, this result is not surprising. A higher incidence of gustatory dysfunction was seen in patients harboring larger-sized tumors although the results were not statistically significant. A larger tumor usually would naturally cause a more significant seventh nerve compression; however, the cranial nerve deficits would also depend on several other factors, some of which are often unquantifiable. These include the cisternal course of the seventh nerve, the shape and consistency of the tumor, the arachnoidal planes around the tumor, the degree of brainstem distortion, the age of the patient; the degree of resilience of the brain; and, the coexisting hydrocephalus. Although bitter sensations are perceived in the posterior third of the tongue and are said to be carried by the ninth nerve, traditionally all four taste sensations are tested together. Thus, even bitter sensation was tested by us as has also been done in other studies investigating taste sensations in VS.[4,5,14]

The sensory fibers carrying taste sensation originate from the taste buds of the anterior two-thirds of the tongue and palate. They pass via the chorda-tympani and the greater superficial petrosal nerve (GSPN) to the geniculate ganglion that contains cell bodies of the neuron. The central processes then pass through the nervus intermedius to the nucleus of the tractus solitarius in the medulla. The normal nervus intermedius contains 20% unmyelinated nerve fibers.[15] It has no epineurium or perineurium between the brainstem and the porus acousticus (instead, it is ensheathed by a thin arachnoidal layer), thus making it more susceptible to injury during surgical dissection. The tumor location, injury during facial nerve dissection and minimal anatomical protection contributed to the higher incidence of postoperative taste dysfunction noted in our series. Similar results have also been reported in other studies.[4,5] In the study by Watanabe *et al*.,[5] loss, reduction, change in character and phantom sensations of taste were subjectively assessed by the patients. Taste disturbance was seen in 28.7% patients in the preoperative period and in 34.3% in the postoperative period. In our study, 40.8% patients had a preoperative dysfunction of taste sensations. The latter increased to 45.8% patients in the postoperative period. The spectrum of tumor sizes in the two studies, however, was different. In the former study, 30 tumors were small, 59 were medium-sized and 19 were large or giant. In our study, 78 tumors were giant, 61 were large and only three were medium-sized. The higher incidence of taste dysfunction in our series compared to the one by Watanabe *et al*.,[5] may, therefore, be explained by the much larger size of tumors seen in our study. Similarly, a study by Irving *et al*. quoted overall taste abnormality, either a significant reduction or an alteration in 48% in their series.[4] Some other studies have projected taste and facial neurovegetative dysfunction in up to 43% following VS surgery.[16,17] Pialoux *et al*. noted decrease in quality of life owing to taste dysfunctions in patients with VS.[17] Correlating the tumor size with the postoperative facial nerve function (H and B facial grade) and the gustatory function suggested that the nervus intermedius is equally susceptible to injury as the motor component of the facial nerve itself.

Another significant finding was the status of taste dysfunction following surgery where facial nerve was not preserved (n = 12). In contrast to the expected

Table 5: Follow-up taste involvement versus seventh nerve preservation

Follow-up taste involvement	Improved taste dysfunction	No change	Worsened or developed taste dysfunction	Total
Total	9	68	65	142
Operative findings (anatomical preservation)				
Seventh nerve preserved *n* = 130	9 (6.9)	66 (50.8)	55 (42.3)	130 (100)
Not preserved *n* = 12	0	2 (16.7)*	10 (83.3)	12 (100)
P-value (Chi square tests)	0.441	0.022	0.007	

*Despite seventh nerve not being preserved in 12 patients, two patients did not report any change in taste sensations, Figures in parentheses are in percentage

complete (100%) taste loss, only 83.3% (n = 10) patients complained of taste loss or deterioration. The likely explanation of this may be the overlapping of gustatory areas by different cranial nerve territories (glossopharyngeal, vagus or the opposite side chorda tympani nerves) or the coexisting compensatory mechanism in the distribution of these nerves as noted in studies by Kveton *et al*.[14] Some other otolaryngological studies also depict a similar picture of gustatory dysfunction resulting from damage to the chorda tympani nerve.[14,15,18-20]

Conclusions

Taste function abnormalities are common following VS surgery. All patients should be counseled about this deficit before surgery to avoid any distress caused by taste dysfunction. Although taste dysfunction does not cause any significant disability, it does affect the quality of life and should be included in the perioperative facial nerve functional grading system.

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Accepted on 18-08-2007
Source of Support: Nil, **Conflict of Interest:** None declared.