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## Postoperative/Posttraumatic Gustatory Dysfunction

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### Abstract

Clinical taste testing in humans is far from being routinely performed in ear, nose and throat (ENT) clinics. Consequently, most reports on posttraumatic and postoperative taste disorders are case reports and mainly consist of qualitative (e.g. dysgeusia, metallic taste) taste changes after either head injury or ENT surgery. Since quantitative taste deficiencies (ageusia, hypogeusia) often go unnoticed by the patients, the real incidence of ageusia and hypogeusia after head trauma and various surgical procedures remains largely unknown. This lack of reliable clinical data is partly due to the lack of easy, reproducible and rapid clinical taste testing devices. The present chapter tries to resume the current knowledge on postoperative and posttraumatic taste disorders. Despite the sparse literature, the chapter focuses on those ENT surgical procedures where at least some prospective and systematic studies on gustatory dysfunction exist. Accordingly, taste disorders after middle ear surgery, tonsillectomy and dental interventions are largely discussed.

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### Postoperative Gustatory Dysfunction

#### *History*

The scientific debate on the pathways and nerves carrying the taste fibers started about 200 years ago [1]. There has been a controversy for at least 50–70 years about which nerves are the main taste fibers [2, 3]. The glossopharyngeal, trigeminal and facial nerve were all held for 'the' taste nerve [1]. A number of authors such as Bernard [4], Alcock [5], and Bellingeri [7] pointed out that the facial nerve and especially the chorda tympani could be involved in taste function. Others like Lewis and Dandy [3], Lussana [6] and Magendie [8] associated

gustatory function with the trigeminal nerve. Lussana [2], in reference to his teacher Panizza (see Witt et al. [1]), first clearly identified the trigeminal nerve to provide somatosensory supply for the oral cavity, the chorda tympani to provide gustatory supply for the anterior part and the glossopharyngeal nerve for the posterior part of the tongue, respectively. This was based on observations in subjects with lesions of either the trigeminal nerve, the facial nerve or the chorda tympani [2]. He further corroborated his findings with animal experiments in dogs with various degrees of surgically induced damage to each of the nerves mentioned above [2]. A very nice review on the different pathways proposed by several authors was provided by Lewis and Dandy [3] in 1930.

To conclude this paragraph, it has to be retained that the major knowledge on the anatomical distribution of taste fibers is rather recent and has been possible by clinical observations and taste tests on patients with distinct lesions of the cranial nerves V, VII, IX and X.

### *Subjective Postoperative Complaints*

Patients seeking help because of a taste alteration usually turn out to be suffering from an olfactory problem rather than an isolated gustatory problem [9, 10]. Since ‘taste’ and ‘flavor’ are synonyms in the current language, a decrease in flavor perception will lead to a complaint described as ‘taste loss’. This is mainly due to the influence of retronasal olfaction on flavor perception and underlines the importance of psychophysical taste and smell testing. Unfortunately, many studies only rely on the patients’ complaints and standardized tests have not been available for a long time. Since taste and smell disorders may often occur simultaneously [11, 12], each chemosensory modality should be evaluated separately before drawing any conclusion.

### *Quantitative Gustatory Disorder*

Similar to olfactory disorders [13], gustatory complaints can be divided into two categories. Taste may either be quantitatively or qualitatively compromised. This categorization has proven to be useful in clinical routine. In analogy to olfaction, a total loss of gustatory function would be termed ageusia, while hypogeusia describes a partial loss and normogeusia stands for normal taste function. Isolated losses of any taste modalities are very rare but have been described [14], such as the inability to perceive sweet, while sour, bitter and salty can be tasted [15].

### *Qualitative Gustatory Disorder*

The two main qualitative gustatory disorders are mainly parageusia and phantogeusia. Parageusia is a bad taste elicited by the nutritional intake, which

is otherwise absent [16]. Phantogeusia describes the presence of a permanent intraoral bad taste [17, 18].

## *Causes*

### *Middle Ear Surgery*

The facial nerve carries the gustatory innervation for the anterior two thirds of the tongue and the palate [19]. The gustatory fibers run with the chorda tympani which separates itself from the facial nerve within the temporal bone. The chorda tympani also carries parasympathetic fibers for the main salivary glands of the oral cavity [20]. The chorda tympani further travels unprotected through the middle ear cavity. During middle ear surgery, the chorda is freely exposed within the operative field. It is subject to considerable surgical stress by stretch, injury or dryness, or it is directly sectioned in order to facilitate the surgical approach to the ossicles. Accordingly, following ear surgery, lesions of the gustatory system may produce symptoms such as dysgeusia, hypogeusia, ageusia or mouth dryness [3, 20–25]. Most of these postoperative gustatory affections have been shown to be transitory. However, long-lasting dysgeusia cases have been reported [26].

Systematic investigation of taste functions revealed little and often transitory postoperative subjective complaints, but considerable alterations of measurable ipsilateral taste sensitivity. Saito et al. [26] found the postoperative taste alteration to correlate with the preoperative surgical stress. Although most patients do not present long-term complaints, absent or incomplete taste recovery has been observed in the majority of the investigated subjects. Especially the group with a surgically severed chorda tympani exhibited the worst long-term outcome. Attempts to readapt the sectioned ends of the chorda increase the chances of recovery in taste function after surgery [27, 28]. Macroscopic reexamination of the chorda tympani in operated subjects revealed relatively high rates of intact nerves [29]. However, microscopic analyses of such recovered nerves have shown low numbers of intact and myelinated fibers, but mainly fibrosis.

Considering the frequency of otologic surgery and especially the number of bilaterally operated patients (i.e. for otosclerosis), very few complaints of ageusia, hypogeusia and dry mouth are reported [20, 22]. One of the main reasons for the low frequency of complaints appears to be related to the so-called ‘release of inhibition’ phenomenon [30, 31]. Gustatory afferent inputs from cranial nerves VII, IX, and X converge within the solitary nucleus of the medulla, whereas input from the anterior or posterior portion of the tongue is topographically separated. When the chorda tympani is anesthetized, activity disappears in brain

stem regions usually responding to stimulation of the anterior part of the tongue, while the responsiveness to stimulation of the posterior parts of the tongue increases. Thus, subjective reports of whole-mouth gustatory function may not reflect regional taste function. Even lateralized ageusia may go unrecognized by the patient. However, eating is a whole-mouth experience built of gustatory, somatosensory and trigeminal inputs. Thus, it has been shown that lack of gustatory function can be partly masked by touch [32]. Such ‘taste illusions’ might also account for the poor subjective recognition of taste deficiencies. Beside the injury due to the surgical procedure, there is some evidence that the chorda tympani is already altered in subjects suffering from chronic inflammatory middle ear diseases [33–36]. This is probably due to the aggressive behavior of some middle ear inflammatory processes such as the cholesteatoma which is known to erode adjacent structures in the middle ear [37].

In conclusion, patients undergoing middle ear surgery mostly exhibit altered ipsilateral taste function. However, in the overwhelming majority of cases, this alteration goes unnoticed by the patients and is transitory. Unfortunately, in some patients, dysgeusia persists following middle ear surgery and the therapeutically available options are limited. Although the mechanism of action is not clear, zinc gluconate has recently been shown in a double-blind, placebo-controlled study to improve taste function in idiopathic dysgeusia [38].

#### *Tonsillectomy/Oropharyngeal Surgery*

In contrast to middle ear surgery, taste disorders after tonsillectomy have been systematically investigated only by Tomita and Ohtuka [39]. However, during the last 20 years, several reports have been available about this complication [40, 41]. Compared to the very high frequency at which this surgery is performed, taste complaints are extremely rare. After more than 3,500 tonsillectomies, Tomita and Ohtuka [39] observed only 11 cases (0.3%) of taste problems reported by the patients. These data mainly rely on subjective patient reports. Similar to the gap between subjective and measurable taste disorders following middle ear surgery, the ‘release of inhibition’ phenomenon probably also accounts for this low occurrence of posttonsillectomy gustatory complaints. However, since eating is a whole-mouth experience built out of gustatory, somatosensory and trigeminal inputs, most quantitative localized taste disorders go unnoticed.

A prospective study measuring the taste acuity of the posterior third of the tongue before and after tonsillectomy might unravel more psychophysical taste disturbance than reported by patients. This assumption is mainly based on a large anatomical study conducted by Ohtsuka et al. [42], who examined over 100 tonsillar beds with respect to their vicinity to the lingual branch of the glossopharyngeal nerve (LBGN). Their study revealed that in approximately a quarter of the cases, the LBGN traveled covered and separated from the tonsil by a

muscle layer over its whole course to the base of the tongue. In almost 50% of the cases, the muscle lining of the tonsillar bed was discontinuous and only thin muscle bundles covered the tonsillar capsule and the LBGN. Most interestingly, in nearly 25% of cases, the LBGN was firmly adherent to the tonsillar capsule, due to the complete absence of muscle lining between the tonsillar bed and the LBGN. In these cases, and probably also in a similar percentage of patients undergoing tonsillectomy, taste disturbance may occur on removal of the hypertrophic tonsillar capsule. It may be assumed that such taste alterations, in analogy to chorda tympani-related gustatory disorders, are also transitory. In the few cases so far presented, no therapy could be offered [39–41].

Gustatory dysfunctions after all other kinds of oropharyngeal surgery have been described [43–45]. Beside oncologic surgery (see below), it is mainly the sleep apnea surgery which has been reported to alter chemosensory function [46–51]. The most frequent interventions followed by gustatory complaints are laser uvulopalatoplasty and uvulopalatopharyngoplasty. Although taste perception changes were recorded in all studies, psychophysical taste and smell testing was performed in only one study [50]. No changes in gustatory or olfactory function were reported by these authors. Since no taste buds have been described on the uvula, this finding is not surprising [52]. The obviously present changes in taste perception after sleep apnea surgery could be due to a modification in the retronasal airflow pattern [53–56], modifying ‘flavor’ perception which is widely attributed to ‘taste’. Thus, the reported changes rather reflect olfactory changes. Another possibility is the lingual compression (see below) during surgery which could temporarily alter peripheral taste nerve and bud function. Further studies on patients undergoing sleep apnea surgery could clarify these discrepancies between subjects’ reports and measured gustatory function.

#### *Oncologic Surgery and Radiation Therapy*

In contrast to the previously mentioned surgical procedures, oncologic surgery is far more devastating and taste disorders are frequently reported side effects [57–60]. However, patients barely complain about chemosensory disorders in view of the serious treatment and the severity of the disease. Resection of extensive parts of the oral and cervical structures usually also involves loss of taste fibers. This chapter is not dedicated to enumerate the various head and neck surgical procedures; however, we would like to focus on a special group of patients. Laryngectomized subjects lose their whole flavor perception due to interruption of the naso-laryngo-tracheal continuity. Since the negative pressure necessary for nasal breathing can no longer be produced by laryngectomized patients, ortho- and retronasal olfaction promptly disappears with laryngectomy [61, 62]. This leads to a subjective loss of ‘taste’ in these patients, which can potentially influence

nutritional habits. Unlike patients who underwent other head and neck operations, laryngectomized patients can be helped by relatively simple devices and techniques to temporarily restore ortho- and retronasal olfaction. Orthonasal olfaction can be restored by so-called larynx bypasses consisting of plastic tubes connecting the tracheostoma and the mouth [63–68], while retronasal olfaction is partly possible by a movement termed as ‘polite yawning’ [69].

In addition to the usually mutilating and heavy head and neck surgery, radiotherapy aggravates the gustatory function [70, 71]. Taste disorders after radiotherapy are mainly due to fibrosis and/or necrosis of the salivary glands and the taste buds [57, 58, 70–73]. After radiotherapy, taste buds normally regenerate after months while mouth dryness and salivary gland necrosis seem to persist [72, 74]. Recent therapeutic options could remedy this situation [74].

#### *Microlaryngoscopy, Tracheal Intubation and Other Procedures with Lingual Compression*

Several surgical procedures related to any kind of compression exerted on the tongue during more than several minutes have been described to produce gustatory disorders. Microlaryngoscopy or suspension laryngoscopy have been reported to alter lingual sensitivity and taste [75–77]. Most taste and somatosensory complaints are temporary and cases of persistent gustatory disorders seem to be rare. Tracheal intubation [45, 78–80] and the use of a laryngeal mask [81–84] seem to be at the origin of several cases with transitory or persistent lingual nerve damage. Considering the high frequency of surgical procedures and anesthetics done, these complications are very rarely reported. Similar to laryngoscopy, the most likely mechanisms include anterior displacement of the mandible during insertion of the oropharyngeal airway tubing, compression of the nerve against the mandible, and stretching of the nerve over the hypoglossus by the cuff of the orotracheal tube. Prospective studies investigating the question of lingual compression and dysgeusia or ageusia should further clarify the real occurrence of such complications.

#### *Dental Procedures*

Different types of gustatory complaints have been reported after dental procedures. Unfortunately, most reports are based on case studies and few systematic studies have been undertaken to rule out the frequency and reversibility of such taste disturbances after dental procedures [85, 86]. There is a difference between taste disorders occurring after the use of a dental prosthesis or denture and taste disorders due to an oral surgical act. Compared to the number of dental prostheses, cast alloys and dentures used within the general population, taste problems after such oral devices are very rare [86, 87]. Moreover, Garhammer et al. [86] investigated subjects with dysgeusia after the use of a prosthesis and

alloys and found, in approximately 10% of these cases, allergies towards the used materials to be responsible for the taste disorders [86]. Apart from allergic reactions, age and gender seem to influence taste disorders due to dentures, with women over 55 years and elderly having more taste problems [86, 88]. In most cases, the cause of dysgeusia remains unclear. However, a possible explanation in this patient group is that the use of dentures further weakens the trophic oral balance [89, 90].

Although gustatory disorders after oral and dental surgery have frequently been reported, the vast majority of the literature is based on case studies [91–93]. Beside these few reports, some authors have conducted larger studies in order to evaluate the impact of orthognathic surgery (Le Fort I osteotomy and sagittal split osteotomy) [94] as well as surgical removal of all four third molars on taste function [85, 95]. These studies, in which taste was also psychophysically measured, showed a transitory decrease in taste function for the tongue or the palate, respectively. Within 6–9 months, taste function returned to preoperative values; however, injury to the chorda tympani seemed to be accompanied by less disturbances than laceration of the greater superficial petrosal branch of the facial nerve which provides palatal taste function [85, 94–96]. The few systematic reports seem to underline that taste disturbances are a transitory and often unrecognized phenomenon. However, most smell and taste outpatient clinics have some experience with patients complaining of persistent dysgeusia or mouth perception changes, such as changed saliva consistency or mouth burning [91, 93]. Due to the lack of larger studies, it remains speculative whether these disturbances are related to the anesthesia used [91, 96], the reactivation of any viral infections following the surgical stress [97], or the presence of anatomically aberrant branches of the chorda tympani or the glossopharyngeal nerve [93, 98]. Unfortunately, no curative therapy for such taste disturbances exists so far. This is probably closely related to the largely unknown origin of these complaints. However, it has been shown that the mental status tends to influence the long-term regression of such complaints [99] and zinc gluconate has recently been shown to improve chronic idiopathic dysgeusia [38].

### *Preoperative Patient Information*

In light of these gustatory and mouth perception complications after intra-oral surgical procedures, minimal preoperative patient information needs to be provided. This is not very time consuming and may prevent medicolegal claims. Fortunately, most complications occur rarely and surgical alteration of taste function often goes unnoticed by the patient. Taken together, the sense of taste has a great capacity to compensate for partial loss of function. Thus, most

surgeons may never be confronted with this complication in their patients. However, we strongly recommend to inform patients about the small risk reported in the literature of persistent ageusia, hypogeusia, dysgeusia or even changed mouth perception (e.g. mouth burning). Since these complications occur so rarely, they might be considered to occur independently of the surgeon and his skills. Our experience during the last years in the smell and taste outpatient clinic was that the few cases who presented with dysgeusia after a surgery were particularly upset, not about the complaint itself, but rather about the way the surgeon handled postoperative care. Most patients were told that this would be a transitory disorder. After a while, they felt as if their complaints were considered to be psychiatric symptoms by the surgeon who wanted to get rid of the 'unsuccessful' patients. However, by shortly informing the patients preoperatively that this complication exists, is rare, often transitory but sometimes persistent and not really treatable, such postoperative problems between patients and surgeon could be avoided.

This particularly accounts for middle ear surgery in patients with no preexisting inflammatory process in the middle ear cavity. Patients with otosclerosis have been reported to be more prone [23, 35, 100] to develop dysgeusia than patients with cholesteatoma [35], probably because patients with cholesteatoma already have a damaged chorda and altered taste [33, 36, 101]. In patients with middle ear problems, preoperative assessment of taste might also be considered for medicolegal reasons.

## **Posttraumatic Gustatory Dysfunction**

### *History and Taste versus Smell Disorder*

Ogle [102], who was among the first authors to describe posttraumatic anosmia, stated that the patient he examined '...complained not only of loss of smell, but also of loss of taste'. As previously mentioned, this might solely be attributed to anosmia. Like this report, most cases of chemosensory disorders after brain and head injuries have never undergone psychophysical testing. To our knowledge, the first to investigate the extent of posttraumatic ageusia was Sumner in 1967 [103]. Based on an excellent review of the literature on posttraumatic chemosensory complaints and his own experiments, he concludes that in 9 of 10 cases ageusia is related to anosmia and real ageusia seems to be rather rare. A few years later, Schechter and Henkin [104] examined patients following head injury with quite similar results. Beside several case studies, today no larger study has been reconducted in order to better characterize posttraumatic taste disorders.

## *Causes and Injuries*

Posttraumatic taste disorders can be due to accidentally caustic ingestion [105], brain injury [106] and most often head injury [107, 108]. Beside injury of central structures responsible for taste and smell processing such as the frontotemporal or entorhinal cortex [109], complex and important fractures of the skull base or midface with squeezing or disruption of the cranial nerves VII, IX or X account for posttraumatic taste losses. Anecdotally, ‘positive’ taste changes have been reported after a head injury. In 2 patients, food aversions disappeared obviously after a blow [110], and another 2 patients developed ‘gourmand syndrome’ after a head trauma [111]. Taken together, this suggests that even subtle brain lesions may lead to changes in gustatory function, although this seems to be a rare event.

The more peripheral taste injuries due to severe facial and skull base fractures might be more frequent than reported. However, patients who suffer such severe traumas usually present posttraumatic syndromes. Thus, taste disorders may simply go unnoticed due to their relatively minor impact on quality of life compared to other more invalidating complaints. Further studies are needed to strengthen the weak database on posttraumatic taste disorders.

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