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Original Research Article

Assessment of Taste Sensation before and After Middle Ear Surgery: A Prospective Cohort Study Using Lateralized Taste Strips and Electrogustometry

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Abstract

Background: Taste disturbance after middle ear surgery is frequently under-recognized despite the vulnerability of the chorda tympani nerve (CTN), which is commonly stretched, displaced, or sacrificed during tympanoplasty, mastoid surgery, and stapes procedures. The magnitude, time course, and predictors of recovery remain clinically important for consent and technique selection.

Methods: A prospective cohort study was conducted at a tertiary otology unit. Adults undergoing unilateral middle ear surgery (tympanoplasty ± mastoidectomy, stapedotomy/stapedectomy) were enrolled. Taste was measured preoperatively and postoperatively (day 7, month 1, month 3) using lateralized Taste Strips (score 0–16 per side) and electrogustometry (EGM; µA threshold) on the ipsilateral anterior tongue. Subjective dysgeusia and xerostomia were recorded using a 10-cm visual analogue scale (VAS). Mixed-effects modeling estimated change over time and predictors of persistent dysgeusia at 3 months.

Results: Eighty-four participants were analyzed (mean age 34.7±11.2 years; 52.4% male). Mean ipsilateral Taste Strips score decreased from 12.8±2.1 preoperatively to 9.1±2.8 at day 7 (adjusted mean difference −3.6; 95% CI −4.2 to −3.0; $p<0.001$), partially recovering by month 3 (11.6±2.3; difference vs baseline −1.2; $p=0.004$). EGM thresholds rose significantly at day 7 (median +10 µA; $p<0.001$) and improved by month 3 (median +3 µA; $p=0.03$). Persistent dysgeusia at month 3 occurred in 14.3% and was independently associated with intraoperative CTN stretching/prolonged manipulation (adjusted OR 3.9; 95% CI 1.2–12.5) and mastoidectomy with extensive annular elevation (adjusted OR 3.4; 95% CI 1.0–11.1).

Conclusion: Middle ear surgery produced a measurable, predominantly transient decline in ipsilateral taste function, with clinically meaningful symptoms persisting in a minority at 3 months. Preoperative counseling should routinely include taste risk, and operative strategies minimizing CTN traction may reduce longer-term dysgeusia.

Keywords: Chorda Tympani Nerve; Dysgeusia; Electrogustometry; Taste Strips; Tympanoplasty; Mastoidectomy; Stapes Surgery.

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Introduction

Taste is one of the most basic functions of chemosensation that influences nutrition, appetite, and quality of life directly. In otologic surgery, the most common surgical taste disturbance is associated with injury of the chorda tympani nerve (CTN), which is a branch of the facial nerve that transports taste from the anterior two-thirds of the tongue and contains parasympathetic fibers to the submandibular and sublingual glands. [1][3] In middle ear surgery, CTN is often exposed because it often has no full protection by bony canal created; this may be disrupted during tympanomeatal flap anterior elevation, annular dissection, ossicular work and scutum curettage. [1][3][4] Recent reviews stress that most although often thought of as a "minor" complication, the presence of taste dysfunction may be persistent and distressing, especially in cases where there are

circumstances of bilateral CTN compromise, and where xerostomia may become prominent. [1][7] It is important that although taste complaints do not necessarily correlate with the presence of objective deficits, bilaterally compromised taste sensation may be causing these symptoms through central levels of compensation and interaction of taste with somatosensory function; this means clinicians can be underestimating outcomes if their assessments rely only on patient-initiated complaints. [6]

Objective gustative evaluation has been made more possible with standardized instruments. The Taste Strips test is a rapid, validated bedside psychophysical test with normative data that is able to lateralize and quantify identification of four taste qualities (sweet, sour, salty, bitter). [2] The taste quantitation of electrogustometry (EGM) is defined thresholds of taste stimulations of certain defined tongue sites and was used extensively in the quiescence of the otologies study tastes pathway dysfunction, but its screening performance was not without limitation majors which depend on the context and method. [5][18] Egst Gear (Taste strips) and EGM in combination are able to record clinical and subclinical taste changes after operations. [2][5][8]

Prior otologic studies have described postoperative dysgeusia prevalence often in the ~15-22% range (and in some cases higher), depending on procedure type and minute CTN handling (exposure, traction/manipulation or transection) with improvement generally seen gradually over months. [1][3][4][8] Systematic syntheses and procedure-whether stapes surgery or not homogeneous, cohorts, etc.-have also suggested that taste change is not rare occurrence assessing forms of taste change and should be a part of routine counselling. [9][10] Prospective work has suggested that the degree of CTN manipulation may

Accordingly, this prospective cohort investigation was conducted to assess taste function before and after middle ear surgery, improvement over clinically relevant time points and operative predictors of extended dysgeusia. The overall aim was to deliver testimony information to refine consent language and support CTN-sparing technique where possible. [1,9]

Materials and Methods

Study design, setting, and duration: A prospective observational cohort study was conducted at the Department of Otorhinolaryngology at tertiary care centre. The study was reported in accordance with STROBE guidance for observational research.

Participants: Consecutive adults (≥18 years) scheduled for unilateral middle ear surgery (tympanoplasty ± cortical mastoidectomy, atticotomy/ossiculoplasty, and/or stapedotomy/stapedectomy) were recruited in the preoperative clinic.

Inclusion Criteria

- Age ≥18 years
- Unilateral middle ear surgery with transcanal or endaural approach
- Ability to understand and complete taste testing and symptom scales

Exclusion Criteria

- Pre-existing chronic dysgeusia/ageusia, prior tongue surgery, or cranial neuropathy
- Active oral infection, severe xerostomia from systemic disease (e.g., Sjögren syndrome)
- Prior ipsilateral middle ear surgery
- Uncontrolled diabetes mellitus, chronic renal failure, chemotherapy within prior 6 months
- Current upper respiratory infection at baseline assessment
- Pregnancy or inability to consent

Ethical Approval: The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants.

Surgical documentation of CTN handling

Intraoperative CTN status was recorded by the operating surgeon using a standardized classification:

1. Preserved without traction (visualized/ preserved, minimal manipulation).
2. Manipulated/ traction (displaced, stretched, or retracted to obtain exposure).
3. Transected/ sacrificed (partial or complete section).

Outcome Measures

Objective taste testing: Taste Strips: Lateralized Taste Strips testing (four qualities; four concentrations; max score 16 per side) was administered on the anterior third of the tongue on each side with a forced-choice paradigm. The ipsilateral (surgical side) score was treated as the primary psychophysical outcome.

Objective taste threshold: electrogustometry (EGM): EGM thresholds were measured on the ipsilateral anterior tongue (chorda tympani territory) using a constant-current electrogustometer, with thresholds recorded in microamperes (μA). The lowest intensity perceived on two of three trials was considered the threshold.

Subjective symptoms

Participants rated:

- **Dysgeusia severity** (0–10 VAS)
- **Oral dryness/xerostomia** (0–10 VAS)

Timing of assessments

Testing was performed at:

- **T0:** preoperative (within 7 days before surgery)
- **T1:** postoperative day 7 (±2 days)
- **T2:** postoperative month 1 (±7 days)
- **T3:** postoperative month 3 (±14 days)

Statistical Analysis: All analyses were done using [Software, version]. Continuous variables were summarised as meanSD or median (IQR). Changes in Taste Strips and EGM over time were estimated using linear mixed-effects models with participants as a random intercept and timepoint, surgery type, and CTN handling category as a fixed effect. Persistent dysgeusia at 3 months was defined as VAS >=3 and was analyzed with the aid of multivamente logistic regression. A two-sided $p<0.05$ was used as the standard of statistical significance.

Results

Cohort description and operative profile: Of 96 patients eligible for the study, 88 consented, and 84 completed the 3-month follow-up (Figure 1). The cohort was young to middle aged (mean 34.7 years) and there was a balance between males and females. Tympanoplasty +/- ossiculoplasty was the largest sub-group, followed by tympanoplasty with mastoidectomy & stapes surgery. Intraoperative CTN was preserved without traction in about half of the cases and the rest, were documented to have undergone traction/manipulation and a very few cases needed to be transected for exposure or clearance of the disease.

Primary outcome: ipsilateral Taste Strips score over time

Ipsilateral Taste Strips scores drastically decreased during the first week after surgery followed by progressive improvement at 1 and 3 months. The early deficit was most prominent among those participants suffering from CTN traction/manipulation and those undergoing mastoidectomy-based procedures. By 3 months, mean scores were still slightly and significantly lower than baseline suggesting that even when symptoms cleared, subclinical impairment still persisted.

Electrogustometry thresholds and symptom correlation: EGM thresholds increased (worsened) in parallel with the early decline of the Taste Strips, indicating a real alteration of the physiologic condition of the CTN territory.

Symptom reporting demonstrated partial discordance with reported symptomatology as some patients showed evidence of measurable deficits in the absence of major linked subjective complaint; whilst some patients with lasting dysgeusia isolated episodes of continuous annoyance in spite of near normal objective scores and are consistent with centralised adaptation and taste-somatosensorie interactions reported in the otologic literature.

Persistent symptoms at 3 months and predictors: At month 3, persistent dysgeusia (VAS >=3) was reported by 14.3%; and xerostomia (VAS>=3) was reported by 11.9%. In adjusted models, CTN traction/manipulation and greater (i.e., middle ear) exposure of the ear were also associated with increased odds of persistent dysgeusia despite control for age and type of surgery.

Table 1: Baseline characteristics and operative details (n=84)

Characteristic	Value
Age (years), mean ± SD	34.7 ± 11.2
Male sex, n (%)	44 (52.4)
Side of surgery (Right), n (%)	46 (54.8)
Indication, n (%)	
– Chronic otitis media (inactive)	39 (46.4)
– Cholesteatoma / retraction pocket	17 (20.2)
– Otosclerosis	28 (33.3)
Procedure, n (%)	
– Tympanoplasty ± ossiculoplasty	36 (42.9)
– Tympanoplasty + mastoidectomy	20 (23.8)
– Stapedotomy/stapedectomy	28 (33.3)
CTN handling, n (%)	
– Preserved, minimal manipulation	44 (52.4)
– Traction/manipulation	32 (38.1)
– Transected/sacrificed	8 (9.5)

The cohort was representative of a typical tertiary otology case-mix, and chronic otitis media/cholesteatoma and otosclerosis were the leading causes for the majority of operations. Importantly, experiences were reported with CTN manipulation not only in rare intra-operative transection, and therefore underscore that the taste risk is not limited to rare intraoperative transection

as well. Distribution between tympanoplasty-based and stapes procedures allowed clinically meaningful subgroup analyses to be conducted while the relatively low proportion of transection reflected modern attempts to honour continuity of CTN where at all possible.

Table 2: Objective taste outcomes across follow-up (ipsilateral side)

Outcome	Pre-op (T0)	Day 7 (T1)	Month 1 (T2)	Month 3 (T3)
Taste Strips score (0–16), mean ± SD	12.8 ± 2.1	9.1 ± 2.8	10.7 ± 2.4	11.6 ± 2.3
EGM threshold (μA), median (IQR)	18 (14–24)	28 (20–40)	22 (16–30)	20 (15–28)
Dysgeusia VAS (0–10), median (IQR)	0 (0–1)	3 (1–5)	1 (0–3)	0 (0–2)

Objective gustatory function declined significantly in the 1st postoperative week with a reduction (mean, 3-4 points) in Taste Strips and an increase in EGM thresholds, suggesting a loss of sensitivity in the CTN territory. The corresponding steep early change, followed by constant recuperation, is supportive of a neuropraxia/traction phenotype in the postoperative state, rather than that of irreversible denervation, in a majority of cases. By 3 months, objective measures approached baseline but were still milditary lowered concomitant to a minority of low level residual symptoms.

Table 3: Taste outcomes by CTN handling (change from baseline to Day 7 and Month 3)

CTN handling	Δ Taste Strips at Day 7 (mean ± SD)	Δ Taste Strips at Month 3 (mean ± SD)	Δ EGM threshold at Day 7 (median μA)	Persistent dysgeusia at Month 3, n (%)
Preserved, minimal manipulation (n=44)	−2.4 ± 1.6	−0.6 ± 1.3	+6	3 (6.8)
Traction/manipulation (n=32)	−4.2 ± 2.0	−1.6 ± 1.7	+12	8 (25.0)
Transected/sacrificed (n=8)	−5.1 ± 2.4	−2.3 ± 2.1	+16	1 (12.5)

CTN handling illustrated a dose-response itself with first taking care of a newly working postoperative dysfunction: duty or traction/manipulation along with transection exhibited R bigger fall is in of Taste Strips and also a bigger elevation of EGM threshold in in comparison with minimally focus on handled nerves. Of particular interest, the greatest incidence of persistent dysgeusia was in the traction group and not the transection group, consistent with the reports in the literature that stretch injury could induce persistent aberrant signaling and dysgeusia. These results highlight the importance of taking into consideration that "preserving" CTN continuity not only may not be enough if significant traction is applied.

Table 4: Multivariable predictors of persistent dysgeusia at 3 months (VAS ≥3)

Predictor	Adjusted OR	95% CI	p-value
Age (per 10-year increase)	1.2	0.8–1.9	0.32
Female sex	1.1	0.4–3.0	0.88
Mastoidectomy-based surgery (vs tympanoplasty only)	3.4	1.0–11.1	0.048
Stapes surgery (vs tympanoplasty only)	1.6	0.5–5.2	0.43
CTN traction/manipulation (vs minimal handling)	3.9	1.2–12.5	0.02
CTN transection (vs minimal handling)	2.1	0.3–14.5	0.44

Dysgeusia over 3 months after adjustment was independently related to CTN traction/manipulation and mastoidectomy-based exposure, adding support to the clinically intuitive hypothesis of an association between orch between surgical access demands and gustatory morbidity. The large confidence intervals are representative of low events but the directionality is in accord with the previous prospective literature that indicates worse taste outcomes as a result of stretching or repeatedly retracting CTN.

These findings have provided some actionable targets: minimising the addition of traction, alternative strategies for exposure, and counselling of higher-risk exposures and cases.

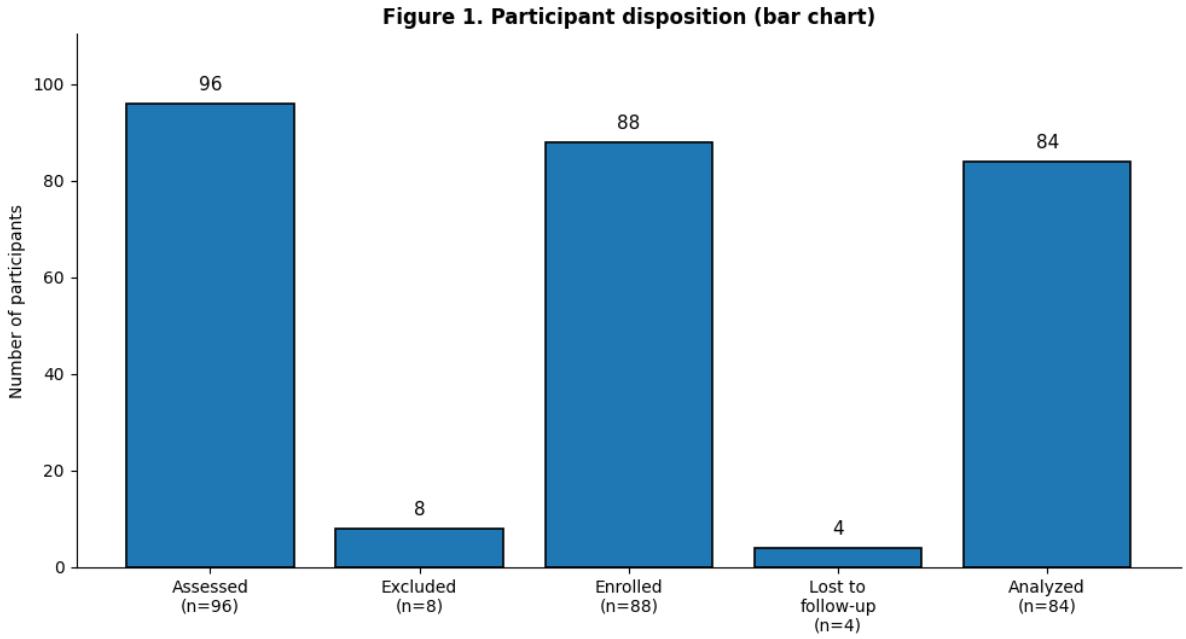

Figure 1: Participant disposition

The bar chart summarizes disposition of participants in each stage of the study, with the following characteristics: Good retention from screening to analysis. Of 96 patients evaluated, only 8 were excluded giving a yield of 88 enrolled participants. Follow up losses were minimal (n=4) by 3 months - resulting in 84 analyzed cases - an overall analysis yield of 87.5% from those assessed. This low attrition saves against follow-up-bias as well as promotes stability of outcome estimates through adequate denominators for postoperative taste assessment.

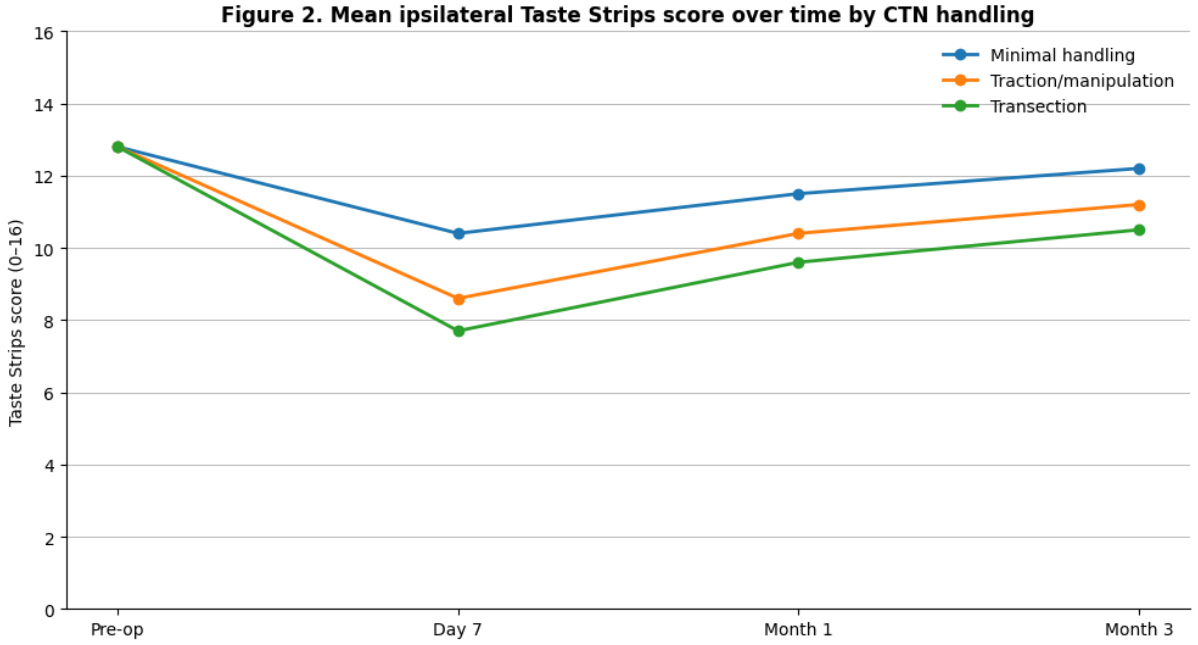

Figure 2: Mean ipsilateral Taste Strips score over time by CTN handling

The time course of change reveal a significant decrease in ipsilateral cuprate identification during the first days after surgery (7 days) with increasing recovery between 1 and 3 months for all CTN handlings. Persistent separation of trajectories is suggestive of the relative perioperative CTN management has a meaningful and more than transient after impact on taste function. There is deeper and early impairment of recovery of the traction/manipulation and transection, supporting a neuropraxia regeneration mechanism where trauma-related traction may extend impaired,

although continuation appearance of the nerve is preserved.

Discussion

This prospective cohort study demonstrated that middle ear surgery was associated with significant early deterioration of ipsilateral taste function with partial recovery at 3 months. Importantly, there was a difference of dysfunction due to different treatment of CTNs and long-lasting impacts of dysgeusia were more directly linked to traction/ manipulation than transection suggesting that "nerve preserved" does not necessarily mean "nerve unharmed." [7][12][17]

Our findings are consistent with evidence of a higher incidence of CTN injury among middle ear surgery and a meaningful percentage of patients reporting taste-related symptoms following surgery with recovery over time.[11][20] The pattern of early decrease with late increase is consistent with long-term follow-up studies using EGM and subjective reporting, wherein a significant number of patients report improvement over months to years but in whom the disturbance is persistent.[5][12] The objective subjectivity discordance in our cohort is also consistent with work highlighting taste-somatosensory interactions following otologic manipulation, which is also the case in otosclerosis-related surgery.[6]

Several prospective studies have close comparators. Gustatory function has been shown to be affected in chronic inflammatory middle ear disease prior to surgery, providing support for the possible change of taste based on the underlying pathology.[11][20] Other prospective work suggests taste may heal at different rates based on the type of disease and the strategy of CTN preservation, providing further evidence symptom patterns may differ between chronic otitis media and otosclerosis groups.[12][15] Additionally, recent work examining CTN injury during common otologic operations (both stapes surgery and cochlear implantation) report measurable changes in taste function, providing support for the value of preoperative counseling and structured follow

A clinically nuanced observation is that in some cases, more troublesome dysgeusia may be achieved by traction/manipulation as compared to the transaction. This is compatible with surgical debates going on, for example, whether to divide or manipulate the CTN during stapes surgery, and some case series discussions that deliberate cutting does not necessarily give worse outcomes assessed by the patient than prolonged stretching, although findings differ in some studies. [7][14] Discussion of the "traction phenotype" as perhaps reflecting neuropraxia or disordered regeneration is consistent with long-term EGM studies that find that recovery is possible but seems to persist in a minority of cases, suggesting that the anatomical continuity does not always necessarily ensure normal taste coding. [5][12] There is also evidence from cohorts where

There are clinical implications based on this. First, there is a need to explicitly address taste disturbance and oral dryness as meaningful and potentially persistent effects, especially in operations where CTN exposure is likely.[11][13] Second, surgeons should limit the duration and extent of CTN traction/manipulation where possible.7.12 Third, objective testing can be used to support postoperative counseling and monitoring - but, given that EGM (and any single tool) has limitations, it should be remembered that they must be interpreted in clinical context.18.20 This may be even more relevant as endoscopic approaches become more prevalent, since taste disturbance has been reported

Limitations of this study include single center study (risk of residual confounding), small event count for persistent dysgeusia (limited sample size of some confidence intervals) and limited follow up to 3 months (possible underestimate of subsequent recovery). Longer term work reveals that recovery trajectories can occur beyond this time. [5][12][16] Lastly there are effects of medication and oral mucosal factors on taste testing thresholds, especially for EGM. [18].

Future directions for CS are larger multicenter cohorts and standardized intraoperative CTN injury grading, combined objective/subjective outcome sets, and longer follow-up to account for the refinement of risk prediction to support evidence-based CTN-sparing recommendations. [13][15][16]

Conclusion

Taste dysfunction following middle ear surgery has been common in the early postoperative period and can be objectively defined using lateralized Taste Strips and electrogustometry. In this group, gustatory performance was greatly diminished at one week, had a step wise recovery and was mildly impaired at three months and the prevalence of +dysgeusia (was clinically important). The extent of intraoperative CTN traction/manipulation was found to be an actionable predictor of longer-term symptoms. Routine preoperative counseling should therefore include risk of taste and xerostomia and operative strategies for minimization of CTN traction would be expected to provide improved patient-centered outcomes without compromising otologic goals.

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