# Taste and Pain Response in Burning Mouth Syndrome With and Without Geographic Tongue

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**Aims:** To assess the effect of geographic tongue (GT) on taste, salivary flow, and pain characteristics in burning mouth syndrome (BMS) to determine whether GT is a contributing factor to BMS and whether BMS and GT represent similar patient populations. **Methods:** A retrospective chart study was conducted. Patients with a diagnosis of BMS or BMS/GT were included. Data regarding smell testing, spatial taste-testing, salivary flow, oral pH, and subjective pain rating on a generalized labeled magnitude scale (gLMS) were collected. **Results:** No significant differences in age, gender, oral pH, smell, or pain were found between groups. Stimulated and unstimulated salivary flow were significantly lower in BMS/GT. Taste responses to all taste stimuli and to ethanol were significantly lower in BMS, with the exception of sour at the fungiform papillae. **Conclusion:** BMS and BMS/GT present with similar clinical pain phenotype and demographics; however, taste was more intact in BMS/GT, suggesting that GT may be a contributing factor in the development of BMS through a mechanism that does not involve taste. *J Oral Facial Pain Headache 2020;34:217–221. doi: 10.11607/ofph.2565*

**Keywords:** *burning mouth syndrome, geographic tongue, pain intensity, taste*

Burning mouth syndrome (BMS) is commonly defined as an oral burning sensation or pain in the absence of objective clinical findings in the oral mucosa for which no medical or dental cause can be found. Depeding on its etiology, BMS can be classified as primary or secondary.[1,2] Primary BMS is classified as idiopathic when a systemic or local cause cannot be identified,[3] and secondary BMS is believed to be the result of allergies/sensitivities, oral infections, oral lesions, nerve injury, trauma, medication side effects, etc.[4] Common symptoms in both primary and secondary BMS include oral burning, oral dryness, and alteration in taste perceptions. In BMS, objective changes in taste have been demonstrated to be present in up to 68% of patients, predominantly affecting bitter, sour, and salty tastes.[5,6] Loss of taste has been hypothesized to be an important part of the etiology of BMS.[7]

Geographic tongue (GT) is believed to be a benign and often asymptomatic incidental finding during dental visits.[8] GT presents as oral lesions that typically appear well demarcated with an atrophic central area, a white margin, and an area of normal appearance and often heals and recurs in the same or a different location.[9,10] Inflammation in tongue tissues has been shown to be present in GT,[11] and GT has been found to be present in 5.6% to 18.1% of patients with a history of psoriasis.[12] Picciani et al[13] found that up to 47% of GT patients also reported oral burning pain.

In a previous study, it was shown that a significantly higher percentage of BMS patients (approximately 27%) compared to controls (approximately 12%) presented with clinical lesions characteristic of GT.[14] In view of the significantly higher prevalence of GT in BMS, the present authors were interested in determining whether GT might be one of the contributing factors for the development of BMS, since the etiology of BMS is likely multifactorial.[2] In the present study, a population of BMS patients with and without GT was assessed to determine whether the presence of GT impacts taste, salivary flow, and pain characteristics previously described in BMS.[2]

**Table 1 Demographics, Salivary Flow, Oral pH, and Smell Identification in the Patient Population (N = 123)**

| | Patients, n | Age, y | Gender, n (%) F | Gender, n (%) M | Salivary flow (mL/5 min) US | Salivary flow (mL/5 min) S | Oral pH | Smell (no. identified/16) |
|---|---|---|---|---|---|---|---|---|
| BMS | 93 | 57.9 ± 10.9 | 76 (81.7) | 17 (18.3) | 2.51 ± 1.86 | 11.40 ± 6.92 | 6.77 ± 0.40 | 12.4 ± 2.2 |
| BMS/GT | 30 | 55.5 ± 10.8 | 23 (76.7) | 7 (23.3) | 1.66 ± 1.07 | 7.69 ± 4.70 | 6.80 ± 0.34 | 12.5 ± 2.5 |
| Statistical comparison (Student *t* test, chi-square test) | | *P* = .298 | $\chi^2$ = .369; *P* = .832 | | **P = .006** | **P = .005** | *P* = .758 | *P* = .855 |

Data are presented as mean ± standard deviation unless otherwise indicated. Significant values are in **bold**. US = unstimulated flow; S = stimulated flow.

## Materials and Methods

### Study Sample

A retrospective chart review was conducted at a private oral medicine clinic in Toronto, Canada. All patients were assessed, diagnosed, and treated by the same clinician (M.G.). All medical charts between January 2014 and September 2018 were reviewed. Inclusion criteria were patients with a diagnosis of oral burning characteristic of primary BMS,[15] either with normal intraoral examination or with presence of oral lesions characteristic of GT on clinical examination,[10] who had their oral pH and salivary flow measured, rated their pain intensity, had spatial taste testing done during the initial visit, and had a signed authorization for retrospective chart review studies. Those who had concurrent complaints of facial pain, dental pain, or temporomandibular disorders (TMD), autoimmune disorders (including Sjogren syndrome and oral lichen planus), or yeast infection were excluded from the study. All patients had normal blood test results. Patients were assigned into two groups: BMS with normal intraoral examination (BMS) or BMS with GT (BMS/GT).

### Salivary Flow Measurement and pH

Patients were asked not to have any food or fluid other than water within 1 hour of their appointment time. Both oral pH and salivary flow measurements were taken prior to intraoral examination.

Oral pH was measured prior to salivary flow measurement with MColorpHast pH-Indicator Strips (4.0-7.0, Merck) by placing the indicator on the tongue and allowing it to saturate completely, then reading the accompanying pH scale.

Salivary flow was measured between 9:30 am and 4:30 pm. Unstimulated flow was measured by asking patients to expectorate into a 10-mL test tube (accurate to 0.1 mL) for 5 minutes while sitting in a quiet room at rest with instructions to not speak for the duration of the test. The amount of saliva collected was recorded after 5 minutes. Stimulated flow was measured by asking patients to repeat this process while chewing a piece of gum (Spry xylitol gum, Xlear) as stimulation.

### Smell Identification Testing

Smell identification testing was performed using the Sniffin' Sticks identification kit (Burghart) with a forced choice procedure.[16] Patients were asked to identify 16 scents in marker form, with each scent corresponding to 4 possible choices. The number of correct identifications was recorded.

### Self-Rated Pain

Patients were asked to rate their pain on waking (am) and their pain in the evening (pm) on a generalized labeled magnitude scale (gLMS)[17] with the descriptors "barely detectable," "weak," "moderate," "strong," "very strong," and "strongest imaginable" on a semi-logarithmic distance scale of 1 to 100.

### Spatial Taste-Testing

Spatial taste-testing was performed using salt (1 M NaCl), sweet (1 M sucrose), sour (0.032 M citric acid), and bitter (0.001 M quinine hydrochloride) solutions. Fifty-percent ethanol was used to test for trigeminal and glossopharyngeal pain sensations.[18] Solutions were placed as a single droplet on the tongue, first on the left fungiform papillae and then the right (chorda tympani), followed by the right then left circumvallate papillae (glossopharyngeal nerve). Patients were asked to identify and rate the intensity of the taste on the same gLMS scale.[17] Patients were asked to wash their mouths out with water between each droplet application of the taste solutions.

### Data Analysis

Data were analyzed with Levene test for variance, chi-square test, and Student *t* test, with a level of significance of *P* = .05.

This study was approved by the Research Ethics Review Board at William Osler Health System, Toronto, Canada.

## Results

A total of 123 patients were included in the study. Ninety-three patients had a diagnosis of BMS, and 30 had a diagnosis of BMS/GT.

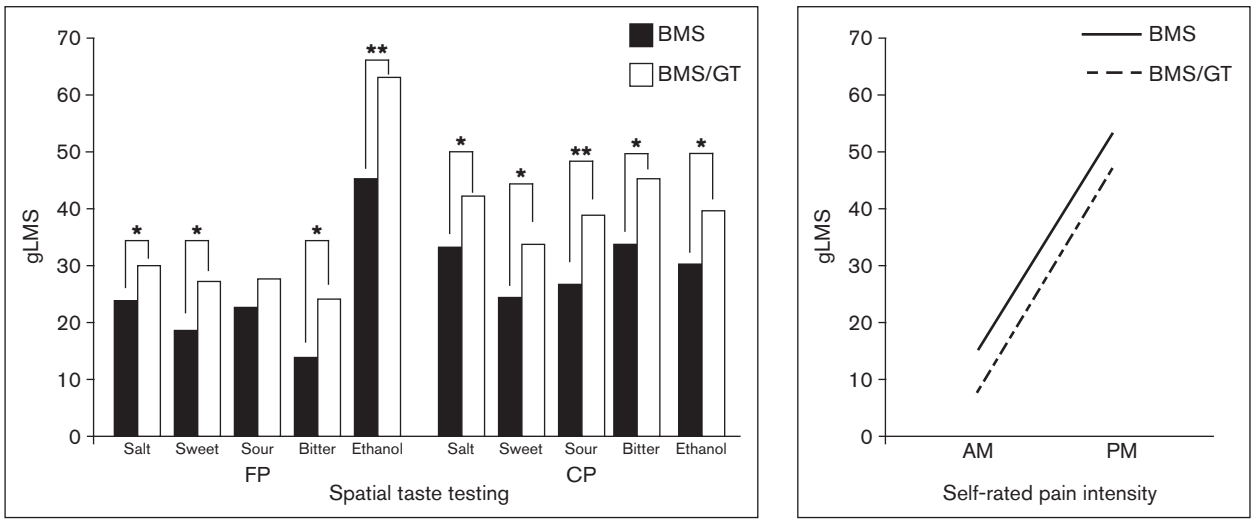


**Fig 1** **(a)** Spatial taste testing and **(b)** subjective increases in pain during the day rated using a 0–100 generalized labeled magnitude scale (gLMS). *$P$ < .05. **$P$ < .001. BMS = burning mouth syndrome; BMS/GT = BMS with geographic tongue; FP = fungiform papillae; CP = circumvallate papillae.

No statistical significance was found between groups with regard to age/gender distribution, smell identification, or oral pH. Stimulated and unstimulated salivary flow were significantly higher in BMS patients compared to BMS/GT patients (Table 1).

Self-rated daily pain variation was similar between BMS and BMS/GT patients, with no statistical significance between groups and a pattern of increasing pain over the day observed for both groups (Table 2 and Fig 1).

BMS patients had significantly lower responses to all taste stimuli and to ethanol at both the fungiform papillae and the circumvallate papillae compared to BMS/GT patients, with the exception of sour at the fungiform papillae (Table 2 and Fig 1).

**Table 2 Spatial Taste-Testing and Self-Rated Daily Maximum and Minimum Pain Intensity in the Patient Population (N = 123)**

| | BMS | BMS/GT | *P* |
|---|---|---|---|
| Spatial taste-testing | | | |
| FP | | | |
| Salt | 23.81 ± 17.28 | 29.88 ± 21.16 | **.047** |
| Sweet | 18.69 ± 15.01 | 27.08 ± 21.20 | **.006** |
| Sour | 22.65 ± 17.25 | 27.63 ± 21.12 | .101 |
| Bitter | 13.92 ± 18.00 | 24.15 ± 21.93 | **.002** |
| Ethanol | 45.06 ± 26.61 | 62.76 ± 26.68 | **< .001** |
| CP | | | |
| Salt | 33.12 ± 19.81 | 42.03 ± 24.44 | **.012** |
| Sweet | 24.33 ± 17.48 | 33.63 ± 23.80 | **.006** |
| Sour | 26.80 ± 18.85 | 38.87 ± 22.42 | **< .001** |
| Bitter | 33.72 ± 22.80 | 45.15 ± 26.93 | **.001** |
| Ethanol | 30.33 ± 23.22 | 39.53 ± 31.51 | **.043** |
| Self-rated pain intensity (0–100 gLMS) | | | |
| AM | 15.10 ± 16.21 | 7.50 ± 3.54 | .524 |
| PM | 53.35 ± 22.97 | 47.81 ± 20.05 | .376 |

Data are presented as mean ± standard deviation unless otherwise indicated. Significant values are in **bold**.
gLMS = generalized labeled magnitude scale; FP = fungiform papillae; CP = circumvallate papillae.

## Discussion

In the present study, BMS and BMS/GT patients had similar demographics, smell identification scores (which were within the normal range[16]), and oral pH (which was also within the normal range). In addition, both groups demonstrated similar patterns in their pain, with a progression of pain intensity over the day.[15] An unexpected finding was the significantly lower stimulated and unstimulated salivary flow measured in BMS/GT than in BMS patients, although all values were within the normal range. Previously, decreased unstimulated salivary flow—but not decreased stimulated salivary flow—has been suggested to be associated with dysfunction of the chorda tympani,[19] which carries parasympathetic innervation to the submandibular and sublingual salivary glands.[20] The lower salivary flow found in BMS/GT in this study was unexpected but may be related to the possibility of a greater impact of inflammation in GT,[11,21] which may affect both parasympathetic and sympathetic stimulation to the major salivary glands. This proposal would require further exploration.

In spatial taste-testing, except for sour at the fungiform papillae, BMS patients demonstrated significantly lower responses to all stimuli compared to BMS/GT, suggesting that

although the clinical pain picture is similar in the two groups, the underlying mechanisms leading to the burning pain may differ.

Taste sensation requires interaction between taste molecules and receptors in the taste buds and the complex innervation involving the chorda tympani and the greater superior petrosal branch of the facial nerve (CN VII), the lingual branch of the glossopharyngeal nerve (CN IX), the superior laryngeal branch of the vagus nerve (CN X), and their central projections into the thalamus and gustatory cortex.[22] In BMS, up to 68% of patients have taste complaints that have been thought to be the result of chorda tympani injury, demonstrated by elevated taste thresholds in electrogustatory studies on BMS.[6,23–28] In the present study, spatial taste-testing demonstrated decreased taste responses to stimuli in BMS, which may be due to the elevated taste thresholds reported in electrogustatory studies.

It has been proposed that damage to the chorda tympani leading to a loss of central inhibition phenomenon on the trigeminal nerve produces the burning pain in BMS patients.[7,28,29] It has also been suggested by Bartoshuk et al that injury to the chorda tympani in BMS is not complete, since in complete bilateral loss of chorda tympani function, loss of inhibition phenomenon was not seen.[18] However, electrogustatory studies on pain threshold in BMS have not been conclusive regarding trigeminal overactivation in BMS, as some studies have demonstrated decreased trigeminal sensitivity,[6,24,30] some increased trigeminal sensitivity,[15,30] and some no change in trigeminal sensitivity.[31]

Histologically, in BMS, there has been found to be loss of myelinated and unmyelinated epithelial nerve fiber density of the tongue,[32–34] as well as upregulation of transient receptor potential vanilloid channel type 1 (TRPV-1) and voltage-gated sodium channels 1 and 8 (Nav1.8), two nociceptive ion channels.[35,36] This differs from findings in GT, where an insignificant increase in the normal neural tissue to connective tissue ratio was demonstrated.[11] In addition, tongue tissue in GT has also been shown to demonstrate an elevated number of Langerhans cells, antigen-presenting cells, and inflammatory mediator interleukin-8, suggesting presence of inflammation,[11,21] which may lead to alteration in taste bud function, change in ion channel activity, and increased response to salt and bitter tastes, as suggested by animal studies.[37–41]

One possibility is that the loss of epithelial nerve fibers and upregulation of nociceptive receptors in BMS together with a decreased chorda tympani function results in decreased sensitivity to taste stimuli in the present patient population, leading to an onset of burning pain, or that an increase in nociceptive receptors leads to onset of burning pain, which in turn suppresses taste sensation carried by the chorda tympani. In contrast, the presence of normal nerve fibers and inflammation in GT patients may indicate the development of burning pain as a result of immune-mediated nerve damage, with less chorda involvement and therefore more preserved taste sensations.

In the present study, BMS/GT patients were similar in age to BMS patients, at a mean age of 55.5 years with a female predominance.[42] However, demographic studies of GT found a higher prevalence in younger populations, with a mean age of 42.6 years and no gender predominance.[10] This discrepancy in age and gender distribution suggests that GT may be a risk factor for developing burning pain later in life, as GT has been found to be more prevalent in BMS,[14] possibly as a result of chronic inflammation compounded with other risk factors, such as female sex and postmenopausal state. However, in these patients, taste changes are less prominent, suggesting less chorda tympani involvement. To the authors' knowledge, this is the first study to examine taste in adult GT patients with symptoms of oral burning.

## Conclusions

BMS and BMS/GT present with similar clinical pictures; however, spatial taste-testing identified these patients as two different patient populations. Patients with BMS/GT demonstrated significantly higher taste and pain perception compared to those with BMS. However, BMS/GT patients were older than the mean age reported for GT in the general population, suggesting that GT may be a risk factor for the development of BMS and appears to act through a mechanism that impacts taste perception to a lesser extent.

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