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Clinical Bitterness Masking Test for Phantogeusia

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Abstract

It is difficult to determine the reason why a patient complains of a bitter taste when their mouth is empty. We examined a new diagnostic test using a bitterness masking substance. The bitterness masking substance, 'Benecoat BMI-60' (hereafter BMI-60), is a masking substance specific to the taste cells' bitterness receptors. After patients gargled with BMI-60 solutions, the phantom sensation of bitterness was masked in some patients, but was not masked in others. Bitter substances in saliva seemed to be masked by BMI-60, but bitterness did not seem to be masked when the locus of the phantom sensation was within the peripheral nerve and/or the brain. The bitterness masking test is useful for diagnosis of the phantom sensation of bitter taste.

Introduction

It is difficult to determine the reason why a patient complains of a bitter taste when their mouth is empty. When no clear evidence is discovered, patients are almost always diagnosed as having psychogenetic symptoms. What is causing the phantom sensation of bitterness? Is there a bitter substance in the saliva or is it a disease of the sense of taste? To distinguish between the former and the latter, a bitterness masking test was examined.

Materials and methods

We examined ten subjects, two male and eight female, who complained of a bitter taste in their empty mouths. We called complaints about this phantom sensation of bitter ness 'phantogeusia'. The age of the subjects was 63.3 ± 9.4 (mean ± SD) years old. The trial began October 1996 and ended July 1999. The subjects gave their informed consent for participation in the study, and experiments followed the World Medical Association Declaration of Helsinki Recommendations guiding physicians in biomedical research involving human subjects. The subjects gargled with 100 ml of 0.5% Benecoat BMI-60 (hereafter BMI-60; KAO Corporation, Tokyo, Japan) with distilled water. BMI-60 contains four lipoproteins—phosphatidic acid, phosphatidylcholine, phosphatidylinositol and phosphatidylethanolamine—and is a specific inhibitor for bitterness (Katsuragi and Kurihara, 1993; Katsuragi *et al.*, 1995, 1996). BMI-60 prepared from soybean lecithin is a safe substance for humans. It is sanctioned as a drug additive by Japan's Ministry of Health and Welfare and as a food additive by Japan's Ministry of Agriculture, Forestry and Fisheries. The subjects were surveyed about whether the phantom sensation of bitterness changed after gargling with the BMI-60 solution. Details of the subjects are shown in Table 1. Prior to the bitterness masking test, patients were measured using an electrogustometer (TR-06; Rion, Tokyo, Japan). The electrogustothresholds of the right and left sides of the chorda tympanic and glossopharyngeal parts of the tongue were measured. In terms of the current of electrogustometric stimulation, 0 dB means 8 μA. For processing, 36 dB was regarded as off the scale of the electrogustometric threshold because maximum output of the TR-06 is 34 dB and its variable step is 2 dB. When the right and left electrogustometric thresholds were different, the lower electrogustometric threshold was regarded as the threshold. All applied methods of electrogustomeasurement followed the protocol of Tomita *et al.* (Tomita *et al.*, 1986). The paper filter disk method (Tomita *et al.*, 1986) was also used for one subject.

Results

The patients were divided into two groups. The first group was composed of the six patients whose phantom sensation of bitterness was masked by BMI-60. The second group was composed of the four patients whose phantom sensation of bitterness was not masked by BMI-60. We called the former and latter BMI-60 'positive' and 'negative', respectively. Details are given in Table 1.

The difference in concentration of zinc levels between BMI-60 positive (82.6 ± 11.4, mean ± SD) and negative

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Table 1 Details of patients

No.	Age	Sex	Complaint	BMI-60	Zinc	Diagnosis	CT	GP
1	49	F	top of tongue tastes bitter	+	67	aloe juice effect	R4, L8	R6, L12
2	72	F	a bitter taste occurs when the right leg feels pain	–	60	unknown phantogeusia	R30, L8	R30, L8
3	67	F	constant bitter taste when the mouth is empty	+	93	brain infarction	R∞, L20	R28,L22
4	64	M	bitter taste in mouth without eating anything	–	83	anosmia and ageusia	R∞, L∞	R26, L30
5	44	F	top of tongue tastes bitter	–	–	cholesteatoma	R24, L24	R18, L14
6	69	F	bitter taste without reason	+	85	aloe juice effect	R4, L8	R18, L18
7	63	F	constant bitter taste when the mouth is empty	+	75	unknown phantogeusia	R34, L∞	R12, L12
8	72	F	bitter taste in mouth without eating anything	+	–	fissured tongue	R14, L20	R28, L∞
9	67	M	constant bitter taste when the mouth is empty	+	93	unknown phantogeusia	R10, L10	R24, L24
10	66	F	constant bitter taste when the mouth is empty	–	83	diabetes	R∞, L∞	R28, L30

BMI-60 '+' and '–' mean that the phantom sensation of bitter taste is masked or not masked, respectively. The unit of plasma level of zinc is μg/dl. CT and GP mean the electrogustometric threshold level (dB) of chorda tympanic and glossopharyngeal areas of the tongue, respectively. Results off the scale of the electrogustometric threshold level are indicated by '∞'.

(75.3 ± 13.3, mean ± SD) was not significant (Student's *t*-test, $P > 0.05$).

The difference in electrogustometric thresholds of the chorda tympanic area of the tongue between BMI-60 positive (14.3 ± 11.4, mean ± SD) and negative (26.0 ± 13.2, mean ± SD) was not significant (Student's *t*-test, $P > 0.05$). Also, in the glossopharyngeal area of the tongue, the difference between BMI-60 positive (18.3 ± 8.1, mean ± SD) and negative (19.0 ± 9.6, mean ± SD) was not significant (Student's *t*-test, $P > 0.05$).

The paper filter disk measurement method (Tomita *et al.*, 1986) was performed on patient no. 4. The taste thresholds of sweetness (sucrose), saltiness (sodium chloride), sourness (tartaric acid) and bitterness (quinine hydrochloride) in the chorda tympanic area of the right and left sides of the tongue were 1, off the scale, 3 and 1, off the scale, 1, 4 respectively.

Discussion

Aloenin, a bitter substance which is contained in aloe juice, is excreted in the urine of the rat (Hirata *et al.*, 1981). Though there are no reports confirming that aloenin is excreted in saliva, the saliva of habitual aloe juice drinkers may contain aloenin. The two BMI-60 positive patients who were habitual aloe juice drinkers, no. 1 and no. 6, were instructed to stop drinking aloe juice. After the cessation of drinking aloe juice, the phantom sensation of bitterness disappeared. The BMI-60 was able to mask the bitter taste apparently caused by aloenin in the patients' saliva.

Patient no. 2 complained that the phantom sensation of bitterness occurred when pain was felt in her right leg. Although it could not be determined whether this was a psychological or central nervous phenomenon, it is difficult to explain the relationship between the leg pain and secretion of the bitter substance in the saliva when no bitter substance was in her mouth.

It was difficult to diagnose the reason for phantogeusia in three BMI-60-positive patients—nos 3, 7 and 9. It was difficult to obtain evidence showing what medicine for brain infarction causes phantogeusia. BMI-60 blocks the molecules of bitterness receptors stimulated not only by bitter substances, but also for other unknown reasons. Thus, it is thought that something is continuously stimulating the molecules of the bitterness receptors, but the stimulated site was within the bitterness receptors.

In patient no. 4, who had ageusia with anosmia, a central nervous origin was suspected.

In patient no. 5, with dysfunction of the chorda tympanic nerve, the phantom sensation of bitterness caused by the cholesteatoma was not masked by BMI-60. The phantom sensation of bitterness seemed to be produced by stimulation of the cholesteatoma on the chorda tympanic nerve. Therefore, in this case, the phantom sensation of bitterness occurred without any bitter substance present in the mouth.

Patient no. 8, with a fissured tongue, had bleeding from the tongue. If the bitter taste was the taste of blood, the phantom sensation of bitterness may be masked by BMI-60. In this case, the phantom sensation of bitterness disappeared after the bleeding stopped.

Diabetic neuropathy seems to cause dysgeusia (Vescovi *et al.*, 1991). Diabetes might have caused the phantom sensation of bitterness in patient no. 10. Because this phantom sensation is thought to be due to chorda tympanic neuropathy, BMI-60 might not mask the phantom sensation of bitterness.

If the bitterness receptor cells could not sense the stimulant, BMI-60 could not mask bitterness. Therefore, it is expected the BMI-60 maskable subjects have lower electrogustometric thresholds than the non-maskable subjects. But the relationship between bitter maskability of BMI-60 and the electrogustometric threshold was not significant. The bitterness receptor cells might be desensitized by continuous stimulation of the bitterness receptors. Continuous bitterness stimulation may produce not only peripheral, but also

central desensitization. The increased threshold of bitterness of the paper filter disk method measurement in patient no. 4 supports our hypothesis.

The bitterness masking test aids the diagnosis and understanding of phantogeusia.

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