Effect of Inferior Alveolar Nerve Block Anesthesia on Taste Threshold

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Iatrogenic injury following dental treatments and the use of local anesthetics may cause taste disorders. The aims of this study were to investigate quantitative and qualitative changes of taste due to unilateral inferior alveolar nerve block anesthesia and further to evaluate potential effects on taste function related to anesthesia or hypoesthesia of inferior alveolar nerve, possibly occurring after dental procedure.

30 healthy volunteers in their twenties participated in this study (male to female = 1:1, mean age of 24.0±1.8 years). Each subject received inferior alveolar nerve block anesthesia on his or her right side with 2% lidocaine HCl containing 1:100,000 epinephrine. Before and after anesthesia, electrogustometric test and chemical localized test for salty, sweet, sour and bitter tastes were performed on the eight sites in the oral cavity; right and left anterior and lateral tongue and circumvallate papilla of the tongue and soft palate.

Unilateral inferior alveolar nerve anesthesia produced elevation of electrical taste threshold and reduction of intensity ratings for all 4 tastes (salty, sweet, sour and bitter) over anterior and lateral tongue and circumvallate papilla on the ipsilateral side ($p<0.05$). Contralateral sides exhibited decreased intensity ratings for salty and sweet taste ($p<0.05$) on anterior and lateral tongue while there was no significant difference in electrogustometric testing.

Based on the results of this study, it is assumed that unilateral local anesthesia on inferior alveolar nerve can affect chorda tympani and glossopharyngeal nerves on the same side, leading to taste deficits. Taste intensity on the contralateral side may, in part, be deteriorated as well.

Key words : Taste, Anesthesia, Inferior alveolar nerve, Electrogustometry, Chemical localized test

I. INTRODUCTION

Taste provides an important tool for humans to select and evaluate food, and avoid potentially toxic compounds and it is thus important in nutrition and metabolism and the quality of life in general. The peripheral organ in the gustatory system is the taste papilla. Taste papillae in humans have at least four different shapes (circumvallate, foliate, fungiform and filiform papillae) and are located on the tongue, soft and hard palate, pharynx, epiglottis and larynx. Within each taste papilla there are varying numbers of taste buds, the functional unit of the peripheral taste organ.[1)]

Peripheral gustatory neural pathways are complex, consisting of bilateral representation of four branches of three cranial nerves; facial,

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glossopharyngeal and trigeminal nerves.[2] The chorda tympani branch of the facial nerve innervates taste buds on the anterior two thirds of the tongue, and leaves the tongue with the lingual nerve. Rarely, some chorda tympani axons may be shunted to the greater superficial petrosal nerve through the otic ganglion.[3] The greater superficial petrosal branch of the facial nerve innervates taste bud located on the soft palate. Foliate and circumvallate taste buds are supplied by the glossopharyngeal, where the glossopharyngeal and especially the vagus nerves supplies taste buds located in the pharynx and larynx.

Taste function can be affected by numerous factors; aging, endocrine disturbances, upper respiratory infection, olfactory disturbance, smoking, medication and etc. Oral conditions related to taste deficits include salivary hypofunction, poor oral hygiene, removable prosthetic appliances, candidiasis, oral mouth rinses, dentifrice, soft tissue lesions, and etc.[1]

In addition, iatrogenic injury during or subsequent dental treatments and the use of local anesthetics can cause taste disorders.[1] Hotta et al[4] reported taste disturbance in two patients after dental anesthesia by inferior alveolar nerve block. Two of them exhibited taste loss and atrophy of fungiform papillae on the ipsilateral sides. Nerves may be injured when local anesthesia is being administered, either as a result of direct contact with the needle or as the results of adverse neurotoxic effects of the anesthetic compound.[5-9] Though it is generally accepted that most cases of taste disturbance recovers with time, taste changes or loss after dental treatments can be intolerable for the patients and thus particular attention should be paid in clinical setting.

The aim of this study was to investigate quantitative and qualitative changes of taste due to unilateral Inferior alveolar nerve block anesthesia and further to evaluate potential effects on taste function related to anesthesia or hypoesthesia of inferior alveolar nerve which may occur after dental procedure.

Ⅱ. MATERIAL AND METHODS

1. Subjects

30 healthy volunteers in their twenties participated in this study. They consisted of 15 men and 15 women and their mean age was 24.0±1.8 years. To minimize variable factors which possibly affect taste function, followings are excluded; those who had any discomfort on taste and/or olfactory function, history of systemic diseases, poor oral hygiene, who were taking drugs and smokers. Those who had history of allergy to local anesthetic agents were also excluded. All the subjects were accepted for the examination after informed consent.

2. Methods

To investigate changes in taste function after anesthesia, two different tests used in this study were electrogustometric test and chemical localized test for taste qualities; salty, sweet, sour and bitter. The four solutions used for chemical test were 1 M of sodium chloride (NaCl, salty) and sucrose (sweet), 0.032 M of citric acid (sour) and 0.001 M of quinine hydrochloride (QHCl, bitter). All of these concentrations were suprathreshold.

Eight sites in the mouth selected for the taste tests were as follows; right and left anterior and lateral (foliate papilla) tongue and circumvallate papilla of the tongue and soft palate (Fig. 1).[10] The anterior tongue was examined on each side of the front of the tongue from the midline toward the side over a distance of approximately 0.5 inch. Lateral surface of the tongue was examined on the each side anterior to foliate papilla seen along the edges of the tongue. As the circumvallate papillae, large round structures, are located on the rear of the tongue, test was done across the most lateral circumvallate papilla visible. Test area for soft palate was each side posterior to the boundary between hard and soft palates from the midline to the side over a distance of approximately 0.5 inch.[10]

The electrogustometer used in this study was Model EG-IIB produced by Nagashima Medical Instrument Co.(Nagashima, Japan) which was a voltage-controlled constant current supply with output current in the range 3-320μA (-8-32dB). A stainless-steel electrode with a flat 5-mm diameter contact area delivered anodal stimulation. Electrical thresholds from all the eight sites were investigated and then repeated with an interval of 5 minutes11 and their mean values for each experimental site was selected for comparison with those of post-anesthesia.

Each subject was also given a test of chemical localized taste function with the four solutions. This test consists of identifying the quality of each test stimulus and rating the stimulus on an intensity scale from 0 (no taste) to 9 (very strong). One of the four compounds was painted with a cotton swab on one of the eight sites of oral cavity and then the score ranging from 0 to 9 was recorded. Care was taken to ensure that the stimulus did not inadvertently cross the midline and prior to applying different solution, the subjects were asked to rinse their mouths with distilled water.

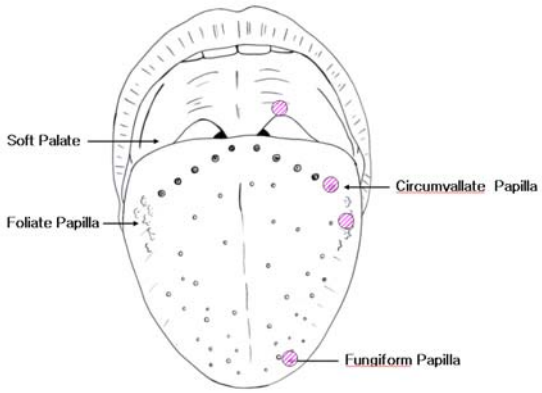

Fig. 1. The sites of oral cavity selected for the taste tests. Tests were performed bilaterally.

After examining the taste function, each subject was taken inferior alveolar nerve block anesthesia with a cartridge (1.8 ml) of 2% lidocaine HCl containing 1:100,000 epinephrine on his or her right side by the experienced dentists. The two taste tests were repeated at about 30 minutes after injection when each subject presented numbness of the mouth, tongue, jaw, chin and lips on the side of injection.

Paired t-tests were used for statistical analysis.

Ⅲ. RESULTS

Electrogustometric test before injection of local anesthetics shows the lowest threshold at the tongue anterior, followed by tongue lateral, circumvallate papilla and soft palate in order (Table 1).

In localized test with four compounds including salty, sweet, sour and bitter taste, intensity scale was the lowest at the soft palate in the subjects (Table 2 to 5).

Table 1. Changes in the electrical taste thresholds after anesthesia.

	Ipsilateral (n=30)		Contralateral (n=30)	
	Before anesthesia	After anesthesia	Before anesthesia	After anesthesia
Tongue ant.	-1.20 ± 5.24	34.90 ± 0.55*	-0.73 ± 6.55	0.00 ± 6.60
Tongue lat.	3.47 ± 6.56	7.53 ± 9.08*	5.00 ± 8.13	7.00 ± 9.11
Circumvallate papilla	7.47 ± 7.14	13.00 ± 10.10*	8.93 ± 7.18	10.07 ± 8.73
Soft palate	12.20 ± 8.07	13.03 ± 7.84	12.07 ± 9.94	12.40 ± 9.62

* ; $p<0.05$ for paired t-tests between before and after anesthesia. (unit:dB)

Table 2. Changes in the mean taste intensity ratings for salty taste after anesthesia.

	Ipsilateral (n=30)		Contralateral (n=30)	
	Before anesthesia	After anesthesia	Before anesthesia	After anesthesia
Tongue ant.	4.17 ± 1.76	0.03 ± 0.18*	3.93 ± 1.66	3.07 ± 1.80*
Tongue lat.	5.80 ± 1.58	3.90 ± 2.31*	6.03 ± 1.63	5.33 ± 1.58*
Circumvallate papilla	4.75 ± 2.08	3.80 ± 2.55*	5.08 ± 1.92	4.37 ± 2.22
Soft palate	0.57 ± 1.14	0.18 ± 0.46	0.33 ± 0.84	0.35 ± 0.66

* ; $p<0.05$ for paired t-tests between before and after anesthesia.

Table 3. Changes in the mean taste intensity ratings for sweet taste after anesthesia.

	Ipsilateral (n=30)		Contralateral (n=30)	
	Before anesthesia	After anesthesia	Before anesthesia	After anesthesia
Tongue ant.	3.40 ± 1.96	0.00 ± 0.00*	3.33 ± 1.81	2.70 ± 1.56*
Tongue lat.	5.70 ± 1.68	3.90 ± 2.35*	5.77 ± 1.83	4.90 ± 1.73*
Circumvallate papilla	4.87 ± 2.29	3.63 ± 2.33*	4.60 ± 2.16	4.30 ± 2.15
Soft palate	0.27 ± 0.83	0.10 ± 0.31	0.23 ± 0.63	0.23 ± 0.57

* ; $p<0.05$ for paired t-tests between before and after anesthesia.

Table 4. Changes in the mean taste intensity ratings for sour taste after anesthesia.

	Ipsilateral (n=30)		Contralateral (n=30)	
	Before anesthesia	After anesthesia	Before anesthesia	After anesthesia
Tongue ant.	3.43 ± 2.21	0.00 ± 0.00*	3.40 ± 2.25	3.00 ± 2.03
Tongue lat.	6.37 ± 1.85	4.50 ± 2.50*	6.37 ± 1.90	5.90 ± 1.67
Circumvallate papilla	5.27 ± 2.36	3.43 ± 2.36*	5.00 ± 2.36	4.47 ± 2.36
Soft palate	0.30 ± 0.79	0.10 ± 0.40	0.37 ± 0.81	0.13 ± 0.35

* ; $p<0.05$ for paired t-tests between before and after anesthesia.

After administration of local anesthesia on the right side, electrical taste threshold increased significantly at the anterior and lateral tongue, circumvallate papilla of the ipsilateral side ($p<0.05$) and elevation of threshold was particularly noticeable at the anterior tongue.of the ispilateral side (Table 1). However, there were no significant differences of electrical taste thresholds at the soft palate of the ipsilateral side and at all 4 sites of the contralateral side.

Unilateral Inferior alveolar nerve block anesthesia decreased significantly taste intensity for the four tastes at the anterior and lateral tongue and circumvallate papilla of the ipsilateral side as compared with those before anesthesia ($p<0.05$). While no significant change in taste intensity due to anesthesia was found at the soft palate of the ipsilateral side (Table 2 to 5), taste intensity for

Table 5. Changes in the mean taste intensity ratings for bitter taste after anesthesia.

	Ipsilateral (n=15)		Contralateral (n=15)	
	Before anesthesia	After anesthesia	Before anesthesia	After anesthesia
Tongue ant.	2.00 ± 1.89	0.00 ± 0.00*	1.67 ± 1.73	1.63 ± 1.73
Tongue lat.	6.53 ± 1.78	5.43 ± 2.50*	6.60 ± 2.08	5.97 ± 2.25
Circumvallate papilla	6.27 ± 2.30	5.23 ± 2.57*	6.37 ± 2.27	6.00 ± 2.33
Soft palate	0.20 ± 0.55	0.03 ± 0.18	0.20 ± 0.55	0.17 ± 0.46

* ; $p<0.05$ for paired t-tests between before and after anesthesia.

salty and sweet taste decreased significantly at the anterior and lateral tongue of the contralateral side ($p<0.05$, Table 2 & 3).

Ⅳ. DISCUSSION

The dentist is the first health care provider accessed by patients with taste disorders, defined as the diminished discrimination of the primary qualities (salty, sweet, sour, bitter and perhaps, metallic), or the presence of dysgeusias (persistent, aberrant tastes).[2] Taste deficits are not only unbearable for the patients, but also frustrating for the dentist, particularly in case that the deficits occurred subsequently related with dental procedures including surgery or local anesthesia. While the dentist is confronted by the task of identifying the type (e.g., salt loss), location, and severity of partial taste loss, quantification and localization of the taste loss is laborious and complex. The detection of malingering is especially difficult, as most tests developed rely on the patient's subjective data. Formal testing can assess quality identification ability, taste thresholds, and suprathreshold function for both whole mouth "real world" function and localized areas of the oral cavity.[2]

Electrogustometric testing is a simple and efficient method of quantitative taste examination, though it can not differentiate taste qualities. Electrogustometry has been used in the assessment of patients with diabetes[12,13] and cancer[14], and as a diagnostic aid in disorders such as Bell's palsy, cerebellopontine tumors, trigeminal nerve disease, and facial paralysis due to suprageniculate lesions.[15-17] Increased acceptance of electrogustometry is due, in part, to an improved understanding of the different transduction mechanisms underlying each of the four basic tastes qualities.[18] Sour taste arises from acid stimuli and is mediated by hydrogen ions.[19] Weak anodal current used in electrogustometry elicits a sour taste experience because protons are liberated at the anode and the medium (saliva) becomes acid. Electrogustometric threshold assessment has been shown to have excellent test-retest reliability.[20]

Whole-mouth test was excluded in this study because there are some studies exhibiting no significant decreases in whole-mouth taste ratings with the chorda tympani nerve blocked or even resected.[10,21,22]

Electrogustometric test and chemical localized test was administrated not only to examine specific areas in oral cavity innervated by different cranial nerves but also to compare side-to-side differences related to unilateral anesthesia.

In this study, inferior alveolar nerve block anesthesia on the right side of each subject produced elevation of electrical taste threshold and reduction of intensity ratings for all 4 taste qualities (salty, sweet, sour and bitter) over anterior and lateral surface and circumvallate papilla of the tongue on the same side.($p<0.05$, Table 1 to 5) Taste deficits on the anterior two-thirds of the

tongue due to inferior alveolar nerve block can be explained by anatomical relation between lingual and chorda tympani nerves. Taste chemoreception from the anterior tongue is carried via the chorda tympani, a branch of the facial nerve, which joins the lingual branch of the Inferior alveolar nerve after the latter has passed through the foramen ovale.[23)]

However, it is difficult to be clear the mechanism that deteriorated the taste function on the posterior one-third of the tongue, the area innervated by glossopharyngeal nerve. According to Lehman's study,[10)] anesthesia of chorda tympani nerve resulted in total taste loss on the anterior tongue and reduced taste on the rear of the tongue, which is consistent with the results in this study. Unlike our results, they found increased taste intensity on the circumvallate papillae. Yamamoto and Kawamura[24,25)] found both inhibitory and excitatory connections between the chorda tympani and glossopharyngeal nerves in the rats and suggested that the influence of the chorda tympani on the glossopharyngeal gustatory function. Changes in blood flow in the tongue can influence gustatory afferent nerve responses,[26)] and such changes could explain effects of one nerve on another on the same side of the tongue. Conflicting findings from ours and Lehman's on the relation between chorda tympani and glossopharyngeal nerves need to be studied further.

While there was no significant difference in electrogustometric testing on the contralateral side of the tongue, the anterior and lateral surface of the tongue exhibited decreased intensity ratings for salty and sweet tastes ($p<0.05$). In the study by Lehman et al.[10)] intensity ratings in contralateral fungiform papillae decreased after anesthesia of chorda typmpani nerve by lingual nerve block, but it didn't happened in case of anesthetizing chorda tympani via ear drum. They described reduced blood supply as a possible answer for their finding. In the Hellekant's study,[26)] it was demonstrated that blood circulation of the tongue significantly influenced gustatory afferent nerve responses. According to his finding, the magnitude of the chorda tympanic response to the same gustatory stimulus decreased by decreasing the blood flow to the tongue. The arterial supply to the tongue is chiefly through the lingual artery, which is a branch from the external carotid artery. At the tip of the tongue, the terminal part of the lingual artery forms an anastomotic loop by joining the artery on the other side.

Negoro et al[27)] studied correlation between the condition of fungiform papillae and taste function. Compared to round shaped papillae and clear blood vessel in normal taste group, in the taste disorder group, flat and irregular papillae were observed with microscopy and blood vessel flow of the papillae was observed to be poor with contact endoscopy.

A case-study by Hotta et al[4)] also demonstrated that two patients received inferior alveolar nerve block revealed taste disturbance in the area innervated by chorda tympani nerve and atrophy of fungiform papillae on the same side.

Unlike our results of chemical localized test, there was no significant change in the electrical taste threshold on the contralateral side. Sensory changes due to the trigeminal nerve block may be an answer' that is, the trigeminal nerve that innervates the soft tissues in which the taste buds are imbedded relays thermal, tactile and pain sensation and interpretation of taste function.[1)] Otherwise, it can be thought that electrogustometer is a more objective and accurate device for assessing taste function.

The extraction of third molar teeth is one of the most common surgical procedures performed in dentistry and one of the most common and accepted risk associated with third molar extraction is damage to peripheral sensory branches of the trigeminal nerve, primarily the inferior alveolar and lingual nerves. After joining the lingual and chorda tympani nerves, they run medial from the mandible, the area of mandibular third molar.[23)]

It is at this point that is most susceptible to damage during surgical procedures. The lesser

palatine nerve, which is responsible for taste chemosenstion of the soft palate, can be damaged during maxillary third molar removal, if the tooth is placed palatally. Damage may be related to the surgical technique or to anatomic variation of chorda tympani-lingual nerve.[28-33]

Taste deficits after third molar surgery may be the result of nerve compression (possibly secondary to edema), stretch, or laceration. They may not result in clean complaints, but they might persist for at least 6 months, or even longer together with other factors that affect taste and accumulate over a lifetime, contributes to the decrease in taste function seen with age.[34,35]

As mentioned earlier, nerves may be injured when local anesthesia is being administered, either as a result of direct contact with the needle or as the results of adverse neurotoxic effects of the anesthetic compound.[5-9]

Considering that dental anesthesia with or without surgery is administered frequently in clinical circumstances, it is recommended to inform the patients of such as taste disturbance and abnormal sensation as the potential postoperative complications, though the complications are rare and temporary, leading to more favorable prognosis.

V. CONCLUSION

Unilateral inferior alveolar nerve block anesthesia produced elevation of electrical taste threshold and reduction of intensity ratings for all 4 tastes (salty, sweet, sour and bitter) over anterior and lateral surface and circumvallate papilla of the tongue on the ipsilateral side.($p<0.05$) On the contralateral side, anterior and lateral surface of the tongue exhibited decreased intensity ratings for salty and sweet taste ($p<0.05$) while there was no significant difference in electrogustometric test.

Based on the results of this study, it is assumed that unilateral local anesthesia on inferior alveolar nerve can affect chorda tympani and glosso-pharyngeal nerves on the same side, leading to taste deficits. In part, taste intensity for certain taste (salty and sweet) on the contralateral side may be deteriorated as well, which needs further studies.

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국문요약

하치조신경 전달마취가 미각역치에 미치는 영향

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치과치료와 관련한 의원성 손상이나 국소마취의 후유증은 미각장애를 유발하기도 한다. 본 연구는 편측 하치조신경 전달마취를 시행하여 마취 전후의 미각기능의 변화를 정량 및 정성적으로 비교하여, 치과치료와 관련하여 발생할 수 있는 하치조신경의 무감각증이나 감각저하로 인한 미각기능의 변화 가능성을 평가하고자 하였다.

20대의 건강한 지원자 30명(남:녀=1:1, 평균연령 24.0±1.8세)을 대상으로 하여 피검자의 우측에 2% 염산리도카인을 사용하여 통법에 따라 하치조신경 전달마취를 시행하였다. 마취 전후 미각기능의 변화를 조사하기 위하여 전기미각측정기를 이용하여 전기미각역치를 측정하였으며 국소적용법을 이용한 화학용액법으로 미각강도를 평가하였다. 검사를 위해 1M/l의 NaCl 및 sucrose 용액, 0.032 M/l의 구연산용액, 0.001 M/l의 염산키니네용액을 사용하였으며 미각강도는 9점 척도를 이용하여 평가하도록 하였다. 검사는 구강내 8 부위, 즉 좌우측 혀 전방과 외측방, 유곽유두, 연구개에 대해 시행되었다.

편측 하치조신경 전달마취를 시행한 결과, 마취된 측의 혀 전방과 외측, 유곽유두에서 전기미각역치가 상승하고 짠맛, 단맛, 신맛, 쓴맛에 대한 미각강도 감소가 감소하였다.($p<0.05$) 마취되지 않은 반대측의 혀 전방과 외측방에서도 짠맛과 단맛의 경우에 대한 미각강도가 감소되었으나($p<0.05$), 전기미각역치의 변화는 없었다.

본 연구의 결과는 편측의 하치조신경 전달마취는 마취가 된 혀의 1/2 부위에서 고삭신경과 설인신경에 영향을 주어 미각장애를 유발할 수 있음을 보여주며, 반대측에서도 미각강도의 변화를 일부 초래할 수 있는 것으로 추측해 볼 수 있다.

주제어 : 미각, 마취, 하치조신경, 전기미각검사, 화학용액법