Changes of Taste Threshold after Smoking in Young Korean Men

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The aim of this study is to determine a relationship between the smoking and the gustation. For that purpose, the survey is about the subjective taste change after smoking compared the electrical taste thresholds by EGM on healthy young Korean men before and after smoking.

The results of the electrogustometry showed significant differences between smokers and non-smokers, also between before smoking and directly after smoking in smokers showed significant differences which indicated the immediate, but temporary effects of smoking on the taste thresholds. There were no difference of gustatory function by the amount of smoking and the degree of addiction.

Based on the results of this study, further studies will be focused on the difference of gustatory function between before and after smoking using the chemical taste test, and the relationship between change of olfactory and gustation by smoking.

Key words : Electrogustometry, Smoking, Taste threshold

Ⅰ. INTRODUCTION

With the olfactory sense, the gustation plays an important role for humans to decide the taste of food. It also works as the protective mechanism against potentially toxic compounds, and the satisfaction provided the pleasures of eating and drinking for the quality of life. The gustation can be affected by numerous factors; aging, gender, olfactory disturbance, medication, ill fitting prosthetic appliances, oral mucosal diseases, various systemic diseases, pregnancy, zinc deficiency, and smoking[1-3].

In humans, the taste buds, serves as the peripheral organ in the gustatory system, are distributed through the tongue and soft palate, mainly the taste buds of the tongue located on the tongue papilla. Tongue papillae have at least four different shapes (circumvallate, foliate, fungiform and filiform papillae). The filiform papillae have no taste bud, so their function is limited to tactile sensation. Sensory nerve fibers that transmit taste information from taste buds to the brain, namely (1) the chorda tympani nerve(anterior 2/3 of the tongue, CN Ⅶ), (2) glossopharyngeal nerve (posterior 1/3 of the tongue, CN Ⅸ), and (3) vagus nerve(esophagus and epiglottis, CN Ⅹ)[4, 5].

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Measurement of gustation in human subjects can be performed by several methods with different types of stimuli: perceived intensity of solutions of different strength and taste qualities, used as a whole mouth wash or applied on parts of the oral mucosa, thresholds to oral solutions, or to solutions instilled in filter paper disks, or in tablets. Electric current stimuli were presented using the electrogustometry(EGM) which has been used for the study of taste loss from various causes, such as age, tonsillectomy, laryngomicrosurgery, extraction of molar teeth, drug side effects, and middle ear surgery. These methods were chosen by subject's response for measuring taste. Involuntary measures of taste pathways involve gustatory evoked potentials, functional magnetic resonance imaging[6]. In Korea, there were some studies used the EGM, which were focused on the effects of age, sex, systemic diseases, and oral diseases on gustation[7-14].

Current smoking includes daily, non-daily, and occasional smoking, oral and nasal cavities are the first organ exposed by smoking. Based on upon weighty evidence that it has a considerable influence on oral health, many negative effects of it have pointed out by several studies, including stain of teeth and dental restorations, decreased ability to smell and taste, and the development of oral diseases such as smoker's palate, smoker's melanosis, coated tongue, and, possibly, oral candidiasis, dental caries, periodontal disease, implant failure, oral precancer and cancer[15, 16]. Despite there are several research related to oral diseases and conditions due to smoking previous mentioned, few studies have been performed to determine the relationship between gustatory function and smoking. And most previous studies have focused on the comparison of the taste thresholds or taste intensities between smokers and non-smokers. However, it has been conducted insufficiently to research about the investigation of the taste thresholds or taste intensities before and after smoking.

The aim of this study is to determine a relationship between the smoking and the gustation. For that purpose, the survey is about the subjective taste change after smoking compared the electrical taste thresholds by EGM on healthy young Korean men before and after smoking.

Ⅱ. MATERIAL AND METHOD

1. Subject

57 Korean young, healthy males participated in this study. The smoker group included 28 smokers and the non-smoker group consisted of 29 non-smokers. All subjects were in good health and reported no taste or smell problems. The smoker group made up a questionnaire about the age, period of the smoking, the daily cigarette consumption, change of taste function due to the smoking and others. The non-smoker group was composed to the similar age of the smoker group. The mean age of the smoker group was 26.1±3.3 years, the non-smoker group was 25.7±3.9 years.

The survey was appraised the amount of smoking at the pack year[the daily cigarette consumption(pack/day) × the duration of smoking(year)], the mean pack year was 5.24±3.83 pack year(1.25-17 pack year). According to the recommendations of the Word Health Organization (WHO), the heavy smoker is that a smoker with a daily cigarettes consumption of more than 20 pieces, but there was no criterion of 'heavy smoker' using pack year. So 5 pack year(the mean pack year of the smokers) was decided on the criterion of 'heavy smoker' in this study. 'Heavy smokers(≧ 5 pack year)' were 12 subjects(43%), and 'light smokers(<5 pack year)' were 16 subjects(57%) (Fig. 1).

In addition, the survey is classified the smokers into 3 categories according to the degree of addiction; the subjects who smoked directly after awakening were classified as severe addiction(3 subjects; 11%), within 1 hour after awakening as moderate addiction(21 subjects; 75%), 1 hour hence after awakening as mild addiction(4 subjects; 14%)(Fig. 2).

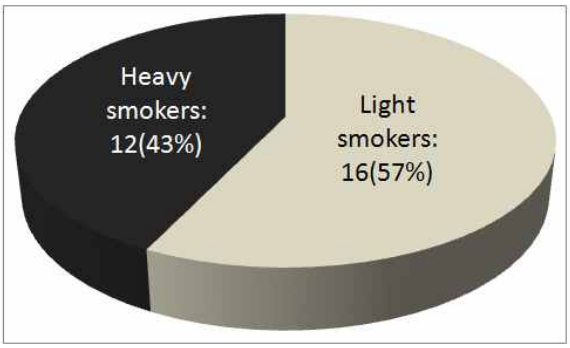

Fig. 1. Classification of the smokers by pack year
Unit: persons(%)

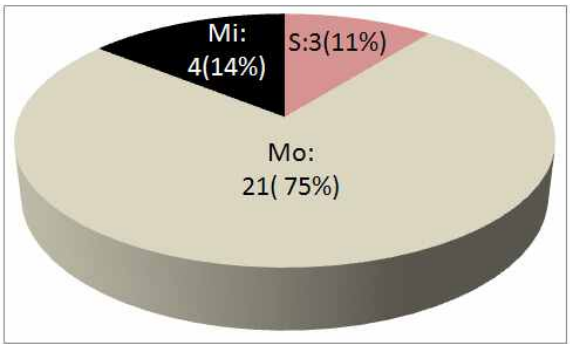

Fig. 2. Classification of the smokers according to the addiction Unit: persons(%)
S(severe addiction) : smoked directly after awakening
Mo(moderate addiction) : within 1 hour after awakening
Mi(mild addiction) : 1 hour hence after awakening

2. Electrogustometric test(EGM)

The electrical stimuli were presented using a Electrogustometer EG-ⅡB(Nagashima Medical Instrument Co., Nagashima, Japan, Fig. 3), and the electrical taste thresholds were measured at 8 different sites in oral cavity; left tongue tip[LA], middle 1/3 of the tongue[LM], posterior 1/3 of the tongue(circumvallate papillae)[LP], soft palate[LS], and right tongue tip[RA], middle 1/3 of the tonguel [RM], posterior 1/3 of the tongue(circumvallate papillae)[RP], soft palate[RS]. The test was proceeded in a comfortable room, free of noise and distraction. After mouth gargle using 5 ㎖ of distilled water for approximately 10 seconds, the subject took a rest for 3 minutes. And then the negative electrode applied to the subject's right hand, the buzzer to the left hand, and the positive electrode to the recording sites. The electrical stimuli for 1 second was given to the patients moving from low to high level. The taste threshold was defined as the lowest detectable level of sour, bitter, or metallic taste of smokers for the first time. The starting current intensity was -8 ㏈ and subsequently increased by 2 ㏈ each time until there was a change in the taste evoked. The electrical taste thresholds of subjects who did not response at 34 ㏈ were regarded as 34 ㏈. The electrical taste thresholds of smokers before smoking were designated as the base data of the smokers(Base). The smokers consumed one

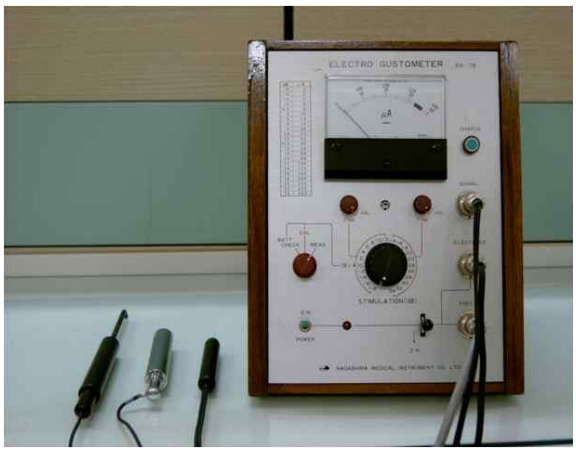

Fig. 3. Electrogustometer, EG-ⅡB

cigarette(RAISON BLUE CAT™, KT&G, Korea, Fig. 3) when they desired to smoke. The electrical taste threshold were measured directly after smoking(After 0), after 20 minutes(After 20), after 40 minutes(After 40), and after 60 minutes(After 60) as previously performed.

3. Statistical analyses

Student's *t*-test were used for statistical analysis about the difference of electrical taste thresholds

Fig. 4. RAISON BLUE CAT™

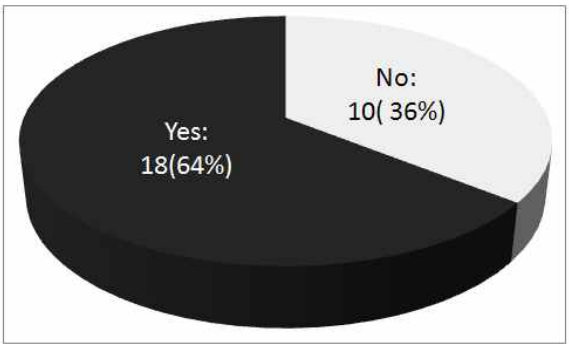

Fig. 5. Results of the answer to question about taste change subjectively after smoking
Unit: persons(%)

between non-smokers and Base, and paired t-test for the difference of electrical taste thresholds between before and after smoking. Pearson correlation coefficient were used for the correlation between the amount of smoking and the difference of electrical taste thresholds, ANOVA for the correlation between the amount of smoking and the taste to match a cigarette, and χ^2(Chi-Square) test for the correlation between the degree of addiction and the difference of electrical taste thresholds. Statistical analyses were performed using a statistical software package SPSS 17.0 (SPSS, Chicago, IL). Differences were considered to be significant at $p < 0.05$.

Ⅲ. RESULT

1. Survey results

Taste change subjectively after smoking(Yes) were 10 persons(36%), no taste change(No) were 18 persons(64%)(Fig. 5).

The tastes to match a cigarette were 'sweet'(13 persons; 46%), 'bitter'(11 persons; 39%), 'sour'(3 persons; 11%), 'salty'(1 person; 4%), 'spicy'(0 person; 0%), and there was no difference of the taste to match a cigarette between heavy smokers and light smokers($p < .05$)(Table 1).

Table 1. The favorite tastes with cigarette

	Heavy smoker group (N=12)	Light smoker group (N=16)	Total
Sweet	5	8	13
Sour	1	2	3
Bitter	6	5	11
Salty	0	1	1
Spicy	0	0	0
Total	12	16	28

* No statistically significant difference between both group ($p < 0.05$)

Table 2. Comparison of electrical taste thresholds between non-smokers and smokers before smoking

(unit : dB)

Group	Location							
	LA	RA	LM	RM	LP	RP	LS	RS
Non-smoking (n=29)	5.24±7.68	4.28±8.50	13.52±9.22	13.59±10.29	12.69±9.55	12.07±9.34	8.62±7.93	10.21±8.84
Smoking (n=28)	6.50±6.52	6.00±6.39	15.50±8.95	21.64±9.52	20.50±9.28	19.93±8.84	16.93±10.52	17.57±10.00
P-value	.508	.392	.414	.003[a]	.003[a]	.002[a]	.001[a]	.005[a]

LA: left tongue tip, RA: right tongue tip, LM: left middle 1/3 of the tongue RM: right middle 1/3 of the tongue, LP: left posterior 1/3 of the tongue
RP: right posterior 1/3 of the tongue, LS: left soft palate, RS: right soft palate
a = $p < 0.05$(P-value by student's t-test)

2. Comparison of electrical taste thresholds between non-smoker and smokers before smoking

The mean electrical taste thresholds of 8 testing sites in non-smoker group were 5.24±7.68dB(LA), 4.28±8.50dB(RA), 13.52±9.22dB(LM), 13.59±10.29dB (RM), 12.69±9.55dB(LP), 12.07±9.34dB(RP), 8.62±7.93 dB(LS), and 10.21±8.84dB(RS). Those of smoker group were 6.50±6.52dB(LA), 6.00±6.39dB(RA), 15.50 ±8.95dB(LM), 21.64±9.52dB(RM), 20.50±9.28dB(LP), 19.93±8.84dB(RP), 16.93±10.52dB(LS), and 17.57± 10.00dB(RS). The data of all testing sites in smoker group were higher each other than those of non-smoker group, and there were significant differences in RM, LP, RP, LS, and RS($p < 0.05$)(Table 2).

3. Comparison of electrical taste thresholds before and after smoking

The mean electrical taste thresholds of 8 testing sites in After(directly after smoking) were 8.93±

Table 3. Comparison of smokers' electrical taste thresholds before and after smoking (unit : dB)

Time	Location							
	LA	RA	LM	RM	LP	RP	LS	RS
After 0	8.93±5.95[a]	10.14±7.12[a]	21.86±8.94[a]	13.86±7.68[a]	13.36±7.22[a]	12.71±8.38[a]	14.57±8.86	8.71±5.11[a]
After 20	7.36±5.42	20.36±8.20[a]	16.93±9.13	21.29±8.61	18.43±9.70	18.43±9.16	14.93±7.82	16.14±10.33
After 40	7.36±4.87	7.29±4.53	20.93±8.60[a]	21.00±9.73	17.57±9.24[a]	17.86±9.03	15.43±8.81	15.50±10.77
After 60	6.50±4.20	7.00±4.54	18.29±7.65	19.57±8.73	15.79±7.78[a]	16.21±8.15[a]	13.64±9.29	13.29±8.44[a]

LA: left tongue tip, RA: right tongue tip, LM: left middle 1/3 of the tongue RM: right middle 1/3 of the tongue, LP: left posterior 1/3 of the tongue
RP: right posterior 1/3 of the tongue, LS: left soft palate, RS: right soft palate
After 0: directly after smoking, After 20: 20 minutes after smoking,
After 40: 40 minutes after smoking, After 60: 60 minutes after smoking
a = $p < 0.05$(P-value by student's t-test)

5.95dB(LA), 10.14±7.12dB(RA), 21.86±8.94dB(LM), 13.86±7.68dB(RM), 13.36±7.22dB(LP), 12.71±8.38dB (RP), 14.57±8.86dB(LS), 8.71±5.11dB(RS), and there were significant differences($p < 0.05$). Also After 20-RA(20.36±8.20dB), After 40-LM(20.93±8.60dB), After 40-LP(17.57±9.24dB), After 60-LP(15.79±7.78 dB), After 60-RP(16.21±8.15dB) and After 60-RS (13.29±8.44dB) showed significant differences($p < 0.05$)(Table 3). There were no difference of electrical taste thresholds by the amount of smoking and the degree of addiction($p < 0.05$).

Ⅳ. DISCUSSION

As pathologic and epidemiologic mechanism of cancer, cardiovascular disease and pulmonary disease is well known, definition of smoking has been changed from 'personal preference' to 'nicotine dependence' which means 'chronic disease which recurs easily but can be completely cured by repeated treatment[17)].

Unfortunately, smoking as disease(nicotine addiction) is underestimated compared with other drug addiction. Because :

1) It is unusual to go to see the doctor because of behavioral intoxication
2) The criteria of drug addiction is how harmful to other people, But the passive smoking is considered as problem recently.
3) Because major tobacco companies have sold tobacco legally, it does not seem necessary to be treated.
4) Many people quit smoking without any particular treatment, unlike alcoholic or other drug addiction, stop-smoking used to be regarded as no treatment has been considered for stop-smoking. The earlier studies have shown danger of smoking. Nevertheless, it is hard to quit smoking. Because smoking is behavioral disorder and nicotine addiction affected by genetic and environmental factor[18)].

WHO realized that tobacco is the most dangerous risk factor to threaten health of human race and established first international agreement about health, Framework Convention on Tobacco Control,(FCTC). In South Korea, Rule against smoking has come up to develop country with ratification of the treaty in 2005[19)]. But there is no trial to improve the antismoking treatment and recognition of smoking as disease in the same reason of above.

Nicotine is mentioned as key component as well as Tar. Nicotine is weak base of pKa 8.0, water soluble and lipid soluble. It is absorbed through the lung, oral, nasal membrane, skin, intestine etc.. In smoking, Nicotine can lead to mental and physical dependence by fast action manifestation and conditioning of positive reinforcement. Symptom of nicotine dependence is tolerance, withdrawal symptom, craving, and impeding of social, occupational ability. Depression, insomnia, anxiety, fears, restless, weight gain and decrease of heartbeat are shown up, while nicotine withdrawal. If Smoking can reduce anxiety and stress, situation lead to anxiety and stress stimulate the need of smoking. Smoking can increase pleasure like social activity, after meal, coffee, alcohol, so attraction for smoking is too strong in that way. Smoking is fossilized in daily life, so during smoking cessation period it could be possible to smoke without any conscious. Withdrawal symptom can be the highest in 24-48 hour after stopping smoking, and decrease slowly for 2weeks, but smokers may feel desire to smoke again, if the stress last for 2weeks more or several years[20)].

Tar contains carcinogen called benzopyrene. Benzopyrene turn into 7, 8-dihydroxy-9, 10-epoxy-7, 8, 9, 10-tetrahydrobenzopyrene(DHEP-BP) by cytochrome P450 and epoxide hydrolase in the body. It is known that leads to cancer by bonding with DNA[21)]. Tar has a deadly poison itself, so fatality for experimental animal is high with small quantity. Tar in the smoke can damage all the organ through the blood vessel from lung and can cause chronic inflammation in gingival, bronchial membrane[22, 23)].

Recently, many kinds of tobacco are selling by domestic and other foreign companies in Korea.

Nicotine and Tar content is different between the companies. If the products are come from same company, there are different grades between brands. For the product differentiation, alteration of tobacco taste is allowed also. According to the personal taste, type of tobacco which is mainly consumed is verified. So it is difficult to decide the type of tobacco for this study. In this study, RAISON BLUE CAT™(Tar 3.0㎎, nicotine 0.3㎎) KT&G was chosen, which has moderate value in Tar and nicotine content. And the entire participant used it. Following study is needed for change of taste threshold according to Tar and nicotine content of tobacco preferred by participant, after smoking.

For the evaluation of subjective taste sensation, the electrogustometric test was used, which measured the gustatory threshold when stimulated by an electrical stress[24], and which could detect taste sensation quantitatively but not qualitatively. EGM was introduced in the clinical assessment of taste sensitivity during the 1950s[24, 25]. Compared to tests based on chemical solutions, EGM is an efficient clinical tool, used in the evaluation of taste disorders caused by different factors such as middle-ear surgery[26], Bell's palsy[27], tumors[28], and tonsillectomy[29]. Increased application of this method is due to its easiness, the short time required and its quantitative character. Pavlidis et al.[30] compared with smokers' and non-smokers' electrical taste threshold and the anatomy of tongue with using EGM and Contact Endoscope, reporting difference between their shape of fungiform papillae and vessels.

In the present study, the results of the EGM showed significant differences between smokers and non-smokers, also between before smoking and directly after smoking in smoker. Our results add to a growing body of evidence which indicates that smoking is associated with taste thresholds of young people that the smoking periods were relatively short.

Previous studies comparing taste thresholds in smokers and non-smokers have reported variable effects, Krut et al.[31] stated smokers shown higher quinine threshold than non-smokers, and Kaplan et al.[32] reported the more older, the more higher quinine and PROP threshold in smokers. At the Baker et al.'s study[33] smokers' salty taste threshold higher than that of non-smokers. Pavlidis et al.[30] suggested smokers' electrical taste threshold higher than that of non-smokers. On the other hand, Khan et al.[34] stated that because there is no difference between reactions of smokers' and non-smokers' taste receptors, taste receptors do not affected by long-term smoking. Kim et al.[35] reported between smokers and non-smokers there is no difference of suprathreshold taste intensities of four basic tastes. Also, At the Park et al.'s study[36] on analysis of electrical taste threshold between smokers and non-smokers did not find correlation between them.

Also the results between before smoking and directly after smoking in smoker showed significant differences which indicated the immediate, but temporary effects of smoking on the taste thresholds. Comparison of taste threshold changes in smokers is made more complicated by the variable methods of testing used in the literature. The thresholds at the tip of the tongue findings tend to suggest an increase in sour but not sweet taste threshold in female smokers[37] and to salt taste in heavy smokers[38]. Using whole mouth taste thresholds, there are also indications that taste may be blunted, but the most robust findings support an effect on bitter, but not other, tastes[31, 39]. Higher sucrose thresholds in female smokers have also been reported, reflecting blunted sucrose taste[40].

Previous studies on relationship of smoking and gustation usually used methods of comparing taste threshold between smokers and non-smokers or methods of evaluating these values quantitatively. Although many studies on evaluation of taste threshold changing mostly used chemical testing, few studies did analysis of electrical taste threshold or suprathreshold taste intensities. So further studies using these methods will be considered, and for evaluating of the cumulative effects of long-term smoking additional studies also need to

be conducted for long-term smoker. Lastly, because smoking behavior performed through airway and olfactory sense that plays important role to taste, future studies will be focused on the relationship between change of olfactory and gustation by smoking.

V. CONCLUSION

The aim of this study is to investigate the difference of electrogustometry thresholds between smoker and non-smoker, and before and after smoking. 28 smokers and 29 non-smokers were chosen from the students of Chosun school of dentistry and the workers of Chosun dental hospital. Electrical taste thresholds were measured at the site of left and right tongue tip, middle-side area of tongue, and soft palate. The smokers were measured immediately after, 20minutes after, 40minutes after, 60minutes after smoking, respectively. Before smoking, electrical taste thresholds difference between of smokers and non-smokers were compared. Also, electrical taste thresholds change according to the amount of smoking and addiction level, and results from a survey about tastes that suit well with cigarette were compared to have following results.

1. Taste change subjectively after smoking were 10 persons(36%), no taste change(No) were 18 persons(64%).
2. The mean electrical taste thresholds of 8 testing sites in smoker group were higher each other than those of non-smoker group, and there were significant differences in right middle 1/3 of the tongue, left posterior 1/3 of the tongue, right posterior 1/3 of the tongue, left soft palate and right soft palate($P > 0.05$).
3. There were significant differences in the mean electrical taste thresholds of all testing sites except of the left soft palate before and after smoking. Also, there were statistically significant differences in the right tongue tip 20 minutes after smoking, the left lateral tongue and circumvallate papilla 40 minutes after smoking, and the left and right circumvallate papilla and the right soft palate 60 minutes after smoking($p < 0.05$).
4. There were no difference of electrical taste thresholds by the amount of smoking and the degree of addiction($p < 0.05$).

In conclusion, the results of the electro-gustometry showed significant differences between smokers and non-smokers, also between before smoking and directly after smoking in smokers showed significant differences which indicated the immediate, but temporary effects of smoking on the taste thresholds. There were no difference of gustatory function by the amount of smoking and the degree of addiction. Based on the results of this study, further studies will be focused on the difference of gustatory function between before and after smoking using the chemical taste test, and the relationship between change of olfactory and gustation by smoking.

REFERENCES

1. Lee EJ, Park WK, Nam JW, Yun JI, Kho HS. Clinical Characteristics of Patients with Taste Disorders. Korean J Oral Med 2009;34:341-351.
2. Robert I. Henkin. Zinc in Taste Function A Critical Review. Biological Trace Element Research. 1984; 6:263-280.
3. Miles TS., Nauntofte B., Svensson P. Clinical oral physiology. Copenhagen, 2004, Quintessence Publishing Co., pp. 53-63.
4. Guyton, A.C., Hall, J.E. Textbook of medical physiology, 9th ed., Philadelpia, 1996, W.B. Sanuders Co., pp. 676-677.
5. Doty RL. Handbook of olfaction and gustation. 2nd ed. Marcel Dekker New York: 2003, pp. 666.
6. Ellegård EK., Goldsmith D., Hay KD., Stillman JA., Morton RP. Studies on the relationship between electrogustometry and sour taste perception. Auris Nasus Larynx 2007;34:477-480.
7. Kim JW, Park JS, Ko MY, Ahn YW. Evaluation of taste in the patients with oral lichen planus by electrogustometer. Korean J Oral Med 2006;31:113-120.
8. Ko MY, Jang YS, Heo JY, Ahn YW. A study on the

taste of burning mouth syndrome patients. Korean J Oral Med 2006;31:275-281.
9. Jun JY, Ahn YW, Ko MY. Evaluation of taste in the patients with recurrent aphthous ulceration by electrogustometer. Korean J Oral Med 2007;32:1-8.
10. Lee YH, Tae IH, Ko MY, Ahn YW. Evaluation of taste in the patients with oral mucosal disease by electrogustometer. Korean J Oral Med 2008;33:133-145.
11. Ko MY, Kwon KM, Heo JY, Tae IH, Ahn YW. A clinical study on the taste threshold of the patients with xerostomia. Korean J Oral Med 2008;33:67-73.
12. Lee YH, Ahn JM, Park JS, Ko MY. Taste of denture wearers. Korean J Oral Med 2004;29:311-319.
13. Kin YS, Yoon CL, Ahn JM, Lee HJ, Kim NR, Ahn BH, Kim S. Taste of type 2 diabetes mellitus patients. Korean J Oral Med 2003;28:401-412.
14. Young-Hee Byun, Sun-Ju Koo, Jae-Kap Choi. Pain threshold & taste threshold variations across the menstrual cycle. Korean J Oral Med 2001;26(3): 253-260.
15. Jesper Reibel. Tobacco and oral diseases update on the evidence, with recommendations. Med Princ Pract. 2003;12(suppl 1):22-32.
16. World Health Organization and FDI World Dental Federation. Tobacco or oral health. An advocacy guide for oral health professionals. Ferney-Voltaire; World Dental Press: 2005.
17. 김영진. 흡연의 원인과 폐해. 흡연과 구강질환. 2008, 대한치과의사협회, pp 13-19.
18. Dani JA, Heinemann S. Molecular and cellular aspects of nicotine abuse. Neuron 1996;16:905-908.
19. Korean Association of Family Medicine. Health promotion in Korea: smoking. Seoul: GoRyo Pub Co.; 2003. p.316-358.
20. Kim DH, Suh YS. Smoking as a disease. Korean J Fam Med. 2009;30:494-502.
21. Hecht, S.S., Carmella, S. G., Chen, M., Miller, A. T., Murphy, S.J., Zimmerman, C. L. and Hatsukami, D. K. Quantitation of urinary metabolites of a tobacco-specific lung carcinogen after smoking cessation. Cancer Res. 1999;59:590-596.
22. Hoffmann, D., Hoffmann, I. The changing cigarette, 1950-1995. J. Toxicol. Environ. Health. 1997;50:307-364.
23. Quandil, R., Sandhu, H., Matthews, D. C. Tobacco smoking and periodontal diseases. J. Can. Dent. Assoc. 1997;63:187-192.
24. Krarup B. A method for clinical taste examinations. Acta Otolaryngol. 1958;49:294-305.
25. MacKenzie ICK. A simple method of testing taste. Lancet. 1955;2:377-378.
26. Kikuchi T., Kusakari J., Kawase T., Takasaka T. Electrogustometry: a method for clinical taste examinations. Acta Otolaryngol (Stockh). 1958;49: 294-305.
27. Hyden D., Sandstedt P., Odkvist LM. Prognosis in Bell's palsy based on symptoms, signs and laboratory data. Acta Otolaryngol 1982;93:407-414.
28. Krarup B. Electrogustometric examinations in cerebellopontine tumors and on taste pathways. Neurology 1959;9:53-61.
29. Dressler D., Conrad B. Taste disorders following tonsillectomy. A rare complication of a common operation. Nervenarzt 1989;60:572-575.
30. Pavlos Pavlidis, Vasilios Nikolaidis, Antonia Anogeianaki, Dimitrios Koutsonikolas, Georgios Kekes, George Anogiannakis. Evaluation of young smokers and non-smokers with electrogustometry and contact endoscopy. BMC Ear, Nose and Throat Disorders 2009;9:9.
31. Krut LH, Perrin MJ, Bronte-Stewart B. Taste perception in smokers and non-smokers. Br Med J. 1961;1:384-387.
32. Kaplan AR, Granville EV, Fischer R. Cumulative effect of age and smoking on taste sensitivity in males and females. J Geronrol 1965;20:334-337.
33. Baker KA, Didcock EA, Kemm JR, Patrick JM. Effect of age, sex and illness on salt taste detection thresholds. Age and Ageing 1983;12:159-165.
34. Khan GJ, Mehmood R, Salah-ud-Din, Ihtesham-ul-Haq. Effects of long-term use of tobacco on taste receptors and salivary secretion. J Ayub Med Coll Abbottabad 2003;15(4):37-39.
35. Kim SH, Hur YK, Choi JK. Suprathreshold taste intensities for sucrose, NaCl, citric acid, and quinine HCl in young koreans and the influence of sex, taste preference, and smoking. Korean J Oral Med 2005;30:149-162.
36. Park SG, Kim SH, Kee WC, Choi JK. Changes in electrical taste threshold with advancing age in Korea. Korean J Oral Med 1998;23:327-341.
37. Sato, K., Endo, S., Tomita, H. Sensitivity of three loci on the tongue and soft palate to four basic tastes in smokers and nonsmokers. Acta Otolaryngol. 2002; Suppl. 546:74-82.
38. Jackson, JA. Heavy smoking and sodium chloride hypogeusia. J Dent Res. 1967;46:742-744.

39. Yamauchi, Y., Endo, S., Yoshimura, I. A new whole-mouth gustatory test procedure. II. Effects of aging, gender and smoking. Acta Otolaryngol. 2002;Suppl. 546:49-59.

40. Pepino, MY., Mennella, JA. Effects of cigarette smoking and family history of alcoholism on sweet taste perception and food cravings in women. Alcohol Clin Exp Res. 2007;31:1891-1899.

국문초록

한국인 청년 남성에서 흡연에 의한 미각역치의 변화

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흡연과 미각간의 상관관계를 알아보고자 조선대학교 치과대학 및 치의학전문대학원에 재학 중이거나 조선대학교 치과병원에 근무 중인 건강한 한국인 청년기 남성들을 대상으로 28명의 흡연자와 29명의 비흡연자를 선발하여, 설문조사 및 전기미각검사를 시행한 결과,

1. 흡연 후 주관적 미각변화가 있는 사람 10 명(36%), 없는 사람 18 명(64%)으로 나타났다.
2. 흡연자의 혀끝, 혀측방, 유곽유두, 연구개에서 흡연 전 전기미각역치는 비흡연자보다 높았다($p < 0.05$).
3. 흡연 전과 흡연 직후의 전기미각역치는 혀끝, 혀측방, 유곽유두 및 연구개에서 흡연 전보다 높았고($p < 0.05$), 시간경과에 따른 수치는 불규칙했다.
4. 흡연자의 흡연량과 중독정도에 따른 전기미각역치의 차이는 관찰되지 않았다.

이상의 결과를 종합할 때, 흡연자와 비흡연자의 전기미각역치간에 있어서 차이가 나타나며, 흡연자는 흡연 직후 흡연으로 인한 미각변화가 발생함을 확인하였다. 그러나 그 영향은 일시적이며, 흡연자의 흡연량과 중독정도에 따른 미각기능의 차이는 관찰되지 않았다. 본 연구 결과를 토대로 앞으로의 연구에서는 화학미각검사법(chemical taste test)을 통한 흡연 전, 후의 미각기능의 차이에 대한 연구가 필요할 것으로 사료되며, 더불어 흡연의 후각기능에 대한 영향도 함께 고려되어야 할 것이다.

주제어 : 미각역치, 전기미각검사법, 흡연