Changes in Salivary Flow Rate and pH in Stressful Conditions

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Ⅰ. INTRODUCTION

Saliva has a number of functions such as digestion of foods, water balance, protection of oral cavity from noxious stimuli, solvent action of chemicals, but perhaps the most important function is to clean the oral cavity and thereby, to contribute to the maintenance of oral health. But these functions can not be accomplished successfully when the salivary flow rate is limited.

Xerostomia, the symptom of oral dryness, is the most common manifestation of salivary gland dysfunction. When xerostomia is present, the mouth becomes dry and the tongue may stick to the palatal mucosa, teeth or buccal mucosa. The patient may also complain about a painful tongue (glossitis), in addition to altered taste and loose denture. Without meticulous oral hygiene, the patient often has rapid cervical carious lesions and acute periodontal diseases. And salivary pH is contributed to CO_2-HCO_3^- buffering system. When salivary pH is low, oral cavity is more susceptible to oral diseases such as dental caries, halitosis, periodontal disease.

Diseases and drugs associated with hypo-salivation are variable. e.g. halitosis, burning mouth syndrome, Sjögren's syndrome, radiation therapy, anticholinergic drug and antihypertensive drugs. And psychiatric factor such as emotional stress can not pass by.

Secretion of saliva is under the control of the autonomic nervous system. In glands with a dual innervation, both parasympathetic and sympathetic nervous systems supply each unit of the salivary glands [1,2].

The physiological responses to emotional stimulation are autonomic and controlled by a complex system involving the limbic structures, especially the amygdala, hypothalamus and reticular formation. Stimulation of the reticular formation induces cerebral arousal, alerting reaction, panic and fear responses. In such stressful situations there are increased systemic circulatory catecholamine levels, derived from increased sympathetic tone augmented by increased adrenal medullary secretion. This is the traditional 'fight or flight' reflex[3].

Many factors can affect salivary flow rate. Local factor such as taste and olfactory stimuli is one of them.

Second, emotional (psychic) stimuli control salivary flow rate. The sight of food, talking about food, or noise of food preparation are sufficient to activate the conditioned reflexes leading to increased salivation[4]. In general, stress can decrease salivary flow rate, while some authors insisted adverse results[5].

So, this thought to be very interesting to evaluate changes in salivary flow rate and pH in stressful conditions.

In order to confirm this academic interest the salivary flow rate and pH during rest and just before written examination for dental students were measured.

Ⅱ. MATERIALS AND METHODS

1. Subjects

This study was performed on twenty subjects, twelve men and eight women, in the age range of 24 to 30 years of dental students of School of Dentistry, Chonbuk National University (Table 1). They had no systemic disease including salivary gland disease.

2. Saliva sampling

The subjects were instructed to give unstimulated saliva samples into a conical tube during rest and just before written examination at 02:00 p.m. The subjects, who held the conical tube for 5 minutes, have been instructed not to swallow during that time. And collected saliva was sealed with paraffin wax film to prevent CO_2 vaporization.

3. Flow rate and pH measurement

Collected saliva was immediately measued by quantity and pH within 30 minutes using cylinder and pH/SEmeter (ORION, 720A model).

4. Statistical Analysis of Data

Paired sample t-test by SPSSWIN(version 7.0) was used for statistical analysis of data. Probability levels of $p<0.01$ were considered statistically significant.

Ⅲ. RESULTS

1. Salivary flow rate and pH during rest (Table 2)

Salivary flow rate during rest was 3.68±1.31㎖/5min in male and 4.93±1.47㎖/5min in female. Salivary pH during rest was 7.63±0.17 in male and 7.43±0.29 in female. There was no sex difference in salivary flow rate and pH.

Table 1. General characteristics of the variables of subjects

	Male	Female	Total
Number	12	8	20
Mean age (Range)	25.8 (24-30)	24.4 (24-25)	25.2 (24-30)

Table 2. Flow rate and pH of saliva during rest (Mean±SD)

	Flow Rate(㎖/5min)	pH
Male (n=12)	3.68±1.31	7.63±0.17
Female (n=8)	4.93±1.47	7.43±0.29
Total (n=20)	4.18±1.48	7.55±0.24

Table 3. Salivary flow rate and pH in rest and stressful conditions

	Rest	Stressful conditions	t-value	p-value
Salivary flow rate (㎖/5min)	4.18±1.48	2.20±0.95	6.32	0.000
pH	7.55±0.24	7.22±0.20	4.61	0.000

2. Salivary flow rate and pH in rest and stressful conditions (Table 3)

Flow rate of unstimulated saliva in rest was 4.18 ±1.48㎖/5min. And flow rate of unstimulated saliva in stressful conditions was 2.20±0.95㎖/5min. There was statistically significant decrease in stressful conditions than rest ($p<0.01$).

Salivary pH of unstimulated saliva in rest was 7.55±0.24㎖/5min and 7.22±0.20㎖/5min in stressful conditions. There was statistically significant decrease in stressful conditions than rest ($p<0.01$).

Ⅳ. DISCUSSION

This study presents how the stress affect human saliva secretory function. The previous studies of the saliva cover from its immunologic compositionary variance, its composition, effect of drugs, treatment of xerostomia and viscosity. But its relationship between stress and salivary flow rate is not yet discussed.

Examination can be considered as a naturally occurring, mainly psychologic stressor, consisting of preparation, anticipation and examination itself. Its high external validity and the easy availability of participants is thought to be for researchers interested in psychoimmunological relationship. In a series of studies from different laboratories, the immunological effects of academic stress has been examined; most results have supported the hypothesis that stress may induce immonsuppression[6].

For making stressful situation, many facts were considered. Studying behavior of students before the examination might be such a factor. Very often, students tend to study in an exhausting manner, especially during the last day before the examination; that is, they study hard for many hours a day without taking sufficient breaks. That exhausting style of working particulary may affect their physiologic condition: as far as we know at present, no data relevant to the conjecture exist. Suh(1999) proposed that orofacial pain was more severe before examination compared to "after examination group"[7]. Thus, saliva was collected just before examination for this study.

Saliva, a dilute solution containing both inorganic and organic constituents, is the first digestive fluid secreted by the alimentary canal. It is a solvent and therefore important in taste function. During mastication, saliva is essential in bolus formation and as a lubricant to facilitate swallowing[8]. Saliva has many functions, but perhaps the most important role of saliva is in the maintenance of oral health. If saliva flow is diminished or stopped altogether for any length of time, the mouth becomes fetid due to decomposition of food debris by bacterial action[10]. And the products of the bacterial action on food are also not diluted, and the buffering action of saliva is lost. This leads, at best, to an increase in caries activity; and, at worst, the crowns of the teeth may dissolve altogether.

Although the function of saliva are similar from species to species, the characteristics of saliva are not. Saliva produced by the various salivary glands in the same animal are different in composition. Even in the same gland, the composition varies depending on the flow rate. On the other hand, there are similarities across animal species when other aspects of salivary secretion are considered. For example, the only way that flow of saliva can be induced or increased is the stimulation of the autonomic nervous system. In addition to the autonomic nervous system, a number of other factors can stimulate salivary secretion, e.g. insulin, thyroid hormone and mineralocorticosteroids. Characteristics of dietry food can affect salivary flow rate. Johansson et al(1989) found that significant reductions in resting and unstimulated salivary flow rates occured in female subjects on a liquid diet, but not on solid diet with the same energy content[9].

The fall in plaque pH after a sugar rinse is great when salivary access to the plaque is restricted than when normal access is allowed, and the pH of saliva is a major factor controlling plaque pH. Since both the pH of saliva and its buffering capacity are controlled by salivary flow rate, an alteration in

salivary output could affect plaque pH[10].

The salivary glands also produce traces of hormones that affect tissue growth and repair, i.e. salivary glands exhibit both exocrine and endocrine functions. Thus salivary glands represent complex organs producing a complex solution, saliva. There is a widespread belief that salivary flow diminishes with age: this may hold true for only a portion of the population[5,11,12].

Emotional states, e.g. anxiety and depression, are known to affect salivary gland function. These effects illustrate the overriding control of the higher central nervous system centres on salivary function.

When xerostomia is present, the mouth becomes dry, the tongue may stick to the palatal mucosa, teeth or buccal mucosa. Sialorrhea (ptyalism) is excesive salivary flow, most commonly seen following the insertion of new prosthodontic or orthodontic appliances. Increased salivary flow rates may also occur during the first trimester of pregnancy, during orgasm, as well as in some disease states, including Parkinson's disease, cerebral palsy and epilepsy, and in some psychological disorders. Excessive salivation may be one of the manifestations of primary herpetic and other infections, but usually disappears on resolution of the problem[11,13].

Saliva has the advantages of being easy to be collected and multiple sample collections can be obtained within a short time frame. The collection technique requires the minimum of instruction and the samples are easily stored. Saliva has been employed in a wide varity of studies, both related and unrelated to stress[14]. When salivary samples are collected on successive days, the second sample can give a slightly higher value than the first. But salivary flow rate seems to be individualized on different occasions.

The emotional state of the patient can also affect the salivary secretion rate : for example, depression causes a decrease, Whereas a positive mood change may have some positive effects on the flow rate[15,16].

One of the most important factor regulating oral health is saliva. For diagnostic and prognostic purposes, the routine dental practice should therefore include the measurement of certain important salivary factors, e.g., flow rate and pH[13]. In psychophysiologic view, this diagnostic methods are considerable.

Becks and Wainwright reported that stimulation decreases the differences in the salivary flow rate among individuals[17]. Some authors suggested that salivary pH correlated with the primary infection of both lactobacilli and yeast. They also reported that the low output of saliva appears to influence the quantity of lactobacilli[13]. Saliva is effective in helping to maintain a relatively neutral pH in the oral cavity, in the bacterial plaque, and on swallowing, in the esophagus as well. In the oral cavity and in the esophagus, the major regulation of pH, especially during eating or drinking, is salivary bicarbonate, the level of which varies directly with flow rate. At rest, bicarbonate content is low, and histidine-rich peptides and, to a lesser extent, phosphates contribute to the buffering action.

The value of saliva in protecting against acids in the oral cavity is being put to a severe test by the large increase in the intake of acidic soft drinks. The importance of saliva in esophageal acid clearane has only recently been recognized (Helm et.al., 1982).

In the bacterial palque, where acid production is the natural sequela to bacterial metabolism of carbohydrates, saliva helps regulate pH in several ways. Bicarbonate, phosphate and histidine-rich peptides act directly as buffers once they have diffused into the plaque. Urea from saliva is converted by bacterial urease to ammonia, which can neutralize acid. Amino acids and peptides can be decarboxylated to form mono-amines and polyamines, a process which consumes hydrogen ions. Arginine and arginine peptides can form ammonia as well as the polyamine, putrescine, and thus can be particularly effective in elevationg plaque pH[8].

In this study , there was a significant decrease in salivary flow rate and an increase in saliva acidity.

V. CONCLUSION

The purpose of this study was to evaluate the difference in salivary flow rate and pH in rest and academic stressful conditions. This study was performed on twenty subjects, twelve men and eight women, in the age range of 24 to 30 years of dental students of School of Dentistry, Chonbuk National University.

Salivary flow rate and pH were measured using conical tube and pH/SEmeter.

The obtained results were as follows:

1. There was no sex difference in salivary flow rate and salivary pH during rest and unstimulated salivary flow rate of adult was 4.18±1.48㎖/5min.
2. There was a statistically significant decrease of salivary flow rate in stressful condition ($p<0.01$).
3. There was a statistically significant decrease of salivary pH in stressful condition ($p<0.01$).

So, it was proposed that academic stress can decrease salivary flow rate and salivary pH in stressful conditions.

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국문초록

스트레스하에서 타액유출량과 수소이온농도의 변화

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타액은 그 양과 조성 등에 있어 많은 인자들의 영향을 받는다. 타액분비 감소는 구강의 자정작용, 완충능, 치아우식저항성 등 타액의 고유한 기능을 변화시켜서 구강건조감, 구강작열감, 다발성 치아우식증 등의 소인이 된다.

이에 저자는 심리적 요인이 구강내 환경에 미치는 영향을 평가하고자 타액선질환을 포함한 전신질환이 없는 전북대학교 치과대학생 20명을 대상으로 일상생활시와 시험 직전의 비자극성 전타액을 5분간 추출하여, 그 유출량과 수소이온농도를 측정, 비교, 평가하였다. 타액유출량은 25㎖의 메스실린더를 사용하였고, 수소이온농도는 pH/SEmeter(ORION, 720A model)를 이용하여 측정하였다.

평가 결과 남성의 비자극성 타액유출량과 수소이온농도는 3.68±1.31㎖/5min와 7.63±0.17이었고, 여성에서는 각각 4.93±1.47㎖/5min와 7.43±0.29로서성별간 유의한 차이가 없었다. 그리고 일상생활시의 성인의 5분간 수집된 비자극성 타액유출량은 4.18±1.48㎖/5min였고, 스트레스하에서의 양은 2.20±0.95㎖/5min로 나타나 스트레스시 타액유출량이 감소하는 것으로 나타났다 ($p<0.01$). 또한 일상생활시의 성인의 비자극성 타액의 수소이온농도는 7.55±0.24였고, 스트레스하에서의 수소이온농도는 7.22±0.20으로 나타나 스트레스시 수소이온농도가 감소하는 것으로 나타났다 ($p<0.01$).

이상의 결과로 보아 스트레스는 타액유출량을 감소시키고 구강내를 보다 산성화시킨다고 사료된다.

핵심용어 : 스트레스, 타액유출량, 수소이온농도