journal of prosthodontic research xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Journal of Prosthodontic Research

journal homepage: www.elsevier.com/locate/jpor

Original article

Psychological stress-relieving effects of chewing — Relationship between masticatory function-related factors and stress-relieving effects —

Akinori Tasaka[a,*], Manaki Kikuchi[b], Kousuke Nakanishi[b], Takayuki Ueda[b], Shuichiro Yamashita[a], Kaoru Sakurai[b]

[a] Department of Removable Partial Prosthodontics, Tokyo Dental College, Tokyo, Japan
[b] Department of Removable Prosthodontics and Gerodontology, Tokyo Dental College, Tokyo, Japan

ARTICLE INFO

Article history:
Received 5 August 2016
Received in revised form 7 April 2017
Accepted 18 May 2017
Available online xxx

Keywords:
Chewing
Psychological stress
Salivary cortisol
Masticatory function

ABSTRACT

Purpose: The objective of the present study was to investigate the relationship between masticatory function-related factors (masticatory performance, occlusal contact area, maximum bite force, number of chewing strokes, and muscle activity) and the stress-relieving effects of chewing.
Methods: A total of 28 healthy male subjects were instructed to rest or chew for 10 min after 30 min of stress loading with arithmetic calculations. Their stress state was assessed by measuring salivary cortisol levels. Saliva was collected at three time points: before stress loading, immediately after stress loading, and 10 min after stress loading. Compared to resting, chewing produced a significantly greater reduction in the rate of change in salivary cortisol levels 10 min after stress loading.
Results: A negative correlation was observed between the rate of decrease in salivary cortisol levels and the number of chewing strokes. No significant correlation was observed between the rate of decrease in salivary cortisol levels and other measurement items.
Conclusion: In healthy dentulous people, the number of chewing strokes has been shown to be a masticatory function-related factor that affects stress relief from chewing, suggesting the possibility that more appropriate chewing would produce a greater effect psychological stress relief.

1. Introduction

Chewing is known to be a stress coping behavior in stressful situations [1], and various reports have addressed the stress-relieving effects of chewing. Suzuki et al. [2] measured fluctuations in blood concentrations of the stress hormones adrenaline, noradrenaline, and adrenocorticotropic hormone, and reported that these secretions were inhibited by gum chewing. In addition to stress hormones in the blood, Morita [3] measured the body's physiological response as an indicator of the body's reaction, and reported that chewing gummy candy or gum reduced psychological stress. However, these reports were based on an invasive approach—collecting blood—and this may have had the unintended effect of stressing the body. Non-invasive methods that have been reported in recent years include determination of stress hormones in the saliva; Tahara et al. [4] and Scholey et al. [5] have shown that chewing after psychological stress loading reduces salivary cortisol levels, which are an indicator of stress.

In turn, there have been studies on the various factors that affect the psychological stress-relieving effects of chewing, including comparative research on differences in chewing speed [6], force [7], and time [8]. Results have shown that psychological stress is relieved by fast chewing more than by slow chewing, and by strong chewing more than by weak chewing. Ten minutes of chewing was also more effective in relieving psychological stress than 5 min of chewing.

Chewing, swallowing, and uttering speech sounds are important oral functions, and are related to physical, mental, and social health [9,10]. Tooth loss and reduced occlusal support can lower masticatory performance and bite force [11], and such a decrease in masticatory function affects not only the state of nutrition, but also psychological condition [12]. However, the relationship between masticatory function and psychological stress relief remains poorly understood.

We hypothesized that differences in masticatory function may influence stress-relieving effects. Therefore, the objective of the

* Corresponding author at: Department of Removable Partial Prosthodontics, Tokyo Dental College, 2-9-18 Misakicho, Chiyoda-ku, Tokyo 101-0061, Japan.
E-mail address: atasaka@tdc.ac.jp (A. Tasaka).

http://dx.doi.org/10.1016/j.jpor.2017.05.003
1883-1958/

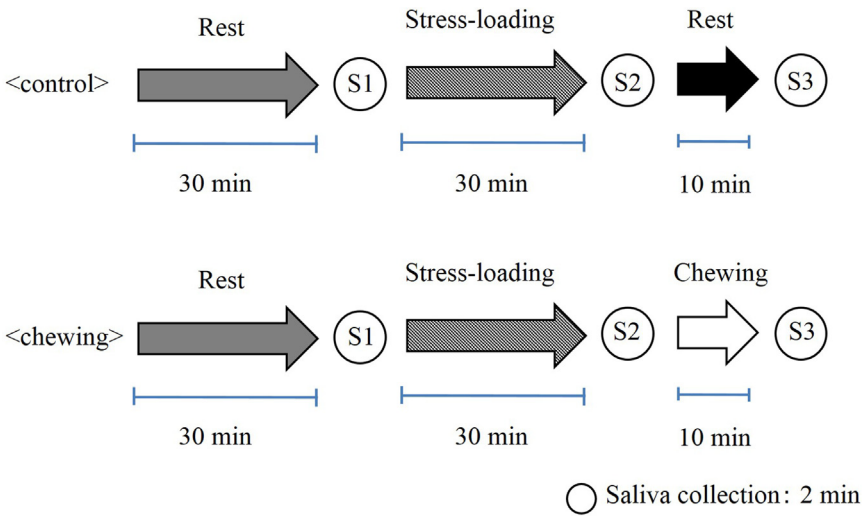

Fig 1. Experimental schedule.

present study was to investigate the relationship between masticatory function-related factors (masticatory performance, occlusal contact area, maximum bite force, number of chewing strokes, and muscle activity) and the stress-relieving effects of chewing.

2. Materials and methods

2.1. Subjects

Subjects were 28 healthy dentulous men (mean age: 30 ± 2 years) both subjectively and objectively free of abnormalities in the stomatognathic system. All subjects had no missing teeth, except for third molars. The protocol of this study was approved by the Tokyo Dental College Ethics Committee (#352). All subjects provided their written consent after receiving a detailed explanation of the experimental protocol.

2.2. Experimental procedures

In consideration of the circadian rhythm of cortisol, the experiment was conducted between 2 PM and 7 PM, when cortisol levels are stable. Subjects were prohibited from eating and drinking [13] or exercising [14] up to two hours before the start of the experiment. The task for the subjects was to rest for 30 min in the laboratory, and then undergo 30 min of stress loading in the form of mental arithmetic calculations of addition, subtraction, multiplication, and division. After the end of the stress loading session, subjects were instructed to rest (control) or chew for ten minutes (Fig. 1). The speed of chewing was not regulated, and was ad libitum for each individual subject. 1.0 g of unflavored gum (Lotte, Saitama, Japan) was used as a chewing sample. The hardness of the gum base is 6.4×10^3 Pa s (soft type). The experiment was conducted on two days—one condition per day—and randomized.

2.3. Measurements and survey items

Salivary cortisol levels—an indicator of the endocrine system—were measured to assess the stress state. Saliva was collected at three time points: after 30 min of rest (S1), immediately after the end of stress loading (S2), and after 10 min of rest or chewing (S3). A Salivette (Sarsted, Rommelsdorf, Germany) was used to collect the saliva. A cotton roll was placed in the mouth for 1 min, and whole saliva was collected. The resulting supernatant of the saliva was cryopreserved at −20 °C. Salivary cortisol levels were measured using a γ-counter (Hitachi Aloka Medical, Tokyo, Japan), by radioimmunoassay.

Masticatory performance, occlusal contact area, maximum bite force, number of chewing strokes, and muscle activity were measured to assess each individual's masticatory function. Masticatory performance was measured using a glucosensor GS-1 (GC, Tokyo Japan). After 2.0 g of gummy jelly was chewed for 20 s, 10 mL of water was added into the mouth, and together they were ejected into a container through a filtration mesh to collect the filtrate. Advantage Test Strips S (Roche Diagnostics K.K, Tokyo, Japan) were inserted into the glucosensor and then the filtrate was collected with the included collecting brush and deposited onto the strips. The amount of glucose eluted was measured three times, and the mean was calculated. Occlusal contact area was measured with a Dental Prescale 50H type R (GC, Tokyo, Japan) and an Occluser FPD-707 (GC, Tokyo, Japan); the occlusal contact area with intercuspation was measured three times with moderate bite force, and the mean was calculated. Maximum bite force was measured with an occlusal force meter GM10 (Nagano Keiki, Tokyo, Japan); the maximum bite force with the left and right first molars was measured three times each, and the left/right means were calculated. A Muscle Tester ME3000P (Mega Electronics, Kuopio, Finland) was used to analyze the number of chewing strokes and the masseter muscle activity during the experiment; the myopotential of the masseter on both sides was derived. The maximal bulk of the masseter on both sides was found by palpation, and surface electrodes (Blue Sensor P-00-S, Medicotest, Olstykke, Denmark) were attached at an interval of 20 mm between electrodes. The surface of the skin at the electrode attachment sites was cleaned with Skin pure (Nihon Kohden, Tokyo, Japan) and disinfecting ethanol, and the resistance between electrodes was set to 8 Ω or below. The number of chewing strokes and total muscle activity for the 10 min of chewing were calculated from the resulting masseter muscle activity.

2.4. Statistical analysis

Salivary cortisol levels were performed to examine the effects of saliva collection times and conditions using two-way repeated measures analysis of variance (ANOVA) at significance levels of 5%. The Bonferroni test was used for post hoc multiple comparisons.

Please cite this article in press as: A. Tasaka, et al., Psychological stress-relieving effects of chewing — Relationship between masticatory function-related factors and stress-relieving effects —, J Prosthodont Res (2017), http://dx.doi.org/10.1016/j.jpor.2017.05.003