MEDWIN PUBLISHERS
Committed to create value for Researchers

Diabetes and Obesity International Journal

Change of Alpha-Amylase Activity in Saliva in Response to Blood Glucose After A High Carbohydrate Ingestion

Nakajima K*

School of Nutrition and Dietetics, Faculty of Health and Social Services, Kanagawa University of Human Services, Japan

***Corresponding author:** Kei Nakajima, School of Nutrition and Dietetics, Faculty of Health and Social Services, Kanagawa University of Human Services, 1-10-1 Heisei-cho, Yokosuka, Kanagawa, 238-8522, Japan, Email : nakajima-rsh@kuhs.ac.jp

Research Article

Volume 2 Issue 2

Received Date: February 23, 2017

Published Date: March 08, 2017

Abstract

Salivary α-amylase activity (SAA) may be correlated with blood glucose levels. However, change of SAA in response to blood glucose after carbohydrate diet remains unknown. In 17 healthy young adults, SAA was inversely correlated with blood glucose levels (r = −0.57, P = 0.02) at 1 h after a high carbohydrate ingestion, corresponding to a nadir in salivary α-amylase activity and a peak in blood glucose, suggesting a close link between these factors.

Keywords: Salivary α-amylase; Blood glucose; Carbohydrate Ingestion

Introduction

Early clinical studies have shown that glucose load in the form of either oral or intravenous route mostly reduces serum and pancreatic amylase, which is greatly manifested around 1h after the load [1-5]. Kayashima et al. [3] and Otsuki et al. [4] found that the obvious reduction in serum (total) and serum pancreatic amylase after glucose load was much prevalent in healthy persons without inflammatory disease such as pancreatitis and hepatitis, although underlying mechanism is unknown [3-5]. Some recent studies have reported inverse associations between salivary α-amylase activity and glucose homeostasis [6-8]. Although serum amylase consists of salivary and pancreatic amylase with almost equal ratio [9], these studies have not revealed the effect of such glucose or starch load on the amylase activity in saliva, which initiates carbohydrate digestion in the oral cavity but the clinical implications is still unclear [10]. For the last decade, in terms of glucose homeostasis and obesity, the clinical relevance of saliva and salivary amylase has been paid much attention than ever before. High salivary amylase, which can be positively associated with high copy number variations in the salivary amylase gene (*AMY1*) [11,12], appears to be associated with lower risk for diabetes and obesity compared with low copy number variations [7,13,14].

Here, in the light of these backgrounds, I report a preliminary result of single arm test in healthy young Japanese persons that shows an acute effect of a high carbohydrate diet on α-amylase activity in saliva (salivary amylase activity) and a significant inverse relationship between salivary amylase activities and blood glucose levels during the carbohydrate load.

Methods

This study was approved by the Ethics Committee of Josai University, Saitama, Japan. All of the participants provided written informed consent for the study. In November and December 2013, we recruited 20 healthy young nonsmoker university students aged 20–22 years. The subjects had no medical history of cardiometabolic diseases or oral diseases. Anthropometric and laboratory tests were performed in the morning after an overnight fast. The subjects were allowed to drink just one cup of water (< 200 mL) 2 h before the tests. Salivary amylase activity in the oral cavity was measured using the Dry Chemistry System (NIPRO, Osaka, Japan). The procedure, which is described in more detail elsewhere [15,16], takes 30 s and is painless. Blood glucose levels were measured using a glucose meter (ACCU-CHEK Aviva; Roche Diagnostics K.K., Tokyo, Japan). Immediately after baseline measurements, the subjects consumed a high carbohydrate diet, comprising two warm balls of white

rice (200 g; energy 295 kcal, carbohydrate 68 g, lipid 0 g, protein 4.2 g, trace minerals and vitamins, and water) with salt (0.8 g) without drinking any fluid. The rice balls were prepared in our laboratory by the stuff members. Salivary amylase activity and blood glucose levels were measured at baseline (i.e., in the fasting state) and at 15, 30, 60, 120, and 180 min after the carbohydrate ingestion.

Data are expressed as the mean ± standard deviation and standard error in the table and figure, respectively. Changes in salivary amylase activity and blood glucose were assessed by repeated-measures analysis of variance. Post hoc analysis was conducted by Bonferroni test. Correlations between clinical variables were examined using Pearson correlation coefficients. Statistical analyses were performed using Statview version 5.0 (SAS Institute, Cary, NC, USA). Values of $P < 0.05$ were considered statistically significant (Bonferroni test, $P < 0.0033$).

Results and Discussion

The 17 subjects completed the carbohydrate load test, although salivary amylase at 30 and 180 min was only measured in 14 subjects. (Table 1) shows the clinical characteristics of subjects at baseline. The baseline mean salivary amylase activity was consistent with the results of previous studies that measured salivary amylase using the same method [16,17].

N (women)	17 (11)
Age (years)	20.6 ± 0.5
Body mass index (kg/m^2)	20.7 ± 1.8
Heart rate (beat per min)	72 ± 10
Salivary amylase activity (kU/L) (range)	56.9 ± 26.1 (28–107)
Blood glucose (mg/dl) (range)	88.0 ± 9.2 (75–102)
Salivary pH	7.5 ± 1.1

Table 1: Baseline characteristics of subjects.

As shown in (Figure 1) blood glucose levels increased for the first 60 min after starch ingestion and gradually decreased thereafter. By contrast, salivary amylase activity decreased reaching a nadir at 60 min (not statistically significant, $P = 0.009$, Bonferroni test) with the smallest standard error, but then increased thereafter. The correlation coefficients between salivary amylase activity and blood glucose levels were −0.33 ($P = 0.19$), −0.33 ($P = 0.19$), −0.21 ($P = 0.48$; $n = 14$), −0.57 ($P = 0.02$), 0.10 ($P = 0.68$), and −0.11 ($P = 0.70$; $n = 14$) at baseline, 15, 30, 60, 120, and 180 min, respectively. Therefore, salivary amylase activity was significantly and inversely correlated with blood glucose levels at 60 min, corresponding a peak in blood glucose and a nadir in salivary amylase activity. Intriguingly, the blood glucose level at 15 min was significantly and inversely correlated with the salivary amylase activity at 30 min ($r = −0.72$, $P = 0.004$, $n = 14$).

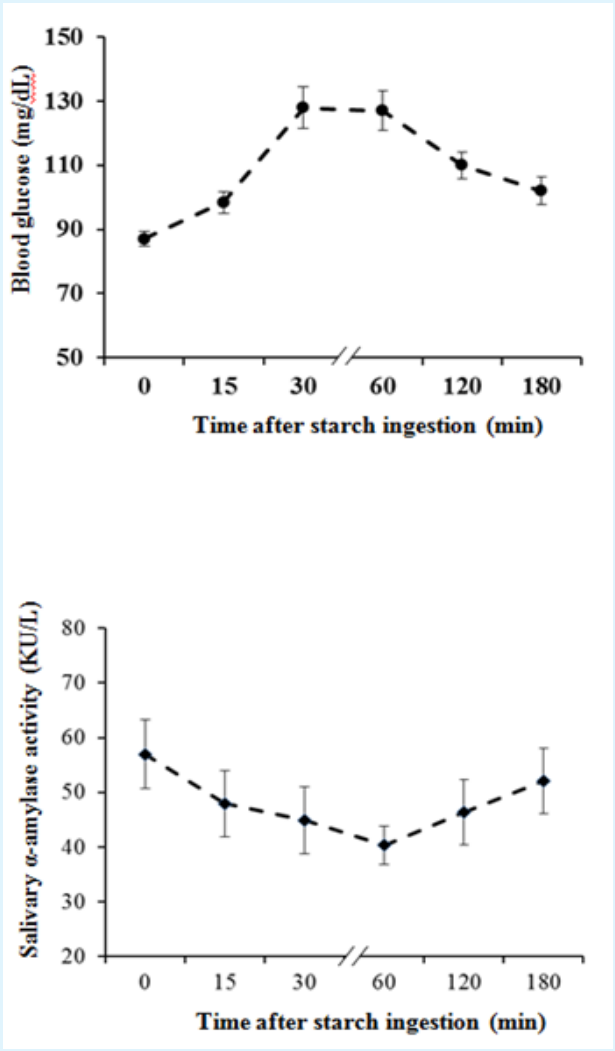

Figure 1: Changes in blood glucose and salivary amylase levels.

Values are expressed as the mean and standard error. Repeated-measures analysis of variance and post hoc test did not reveal a clear reduction in salivary amylase activity until and at 60 min ($P = 0.06$ and $P = 0.009$, respectively), using data obtained at baseline, 15 min, and 60 min. *Blood glucose levels and salivary α-amylase activity were measured in 14 subjects at 30 and 180 min.

Current study demonstrates that α-amylase activity in saliva may decrease around 1h after a carbohydrate diet in healthy persons, which is not inconsistent with previous studies that shows the reduction in serum and pancreatic amylase after glucose load [1-5]. Minimum insulin is considered to be necessary for the production of pancreatic enzymes via insulin receptors [10,18,19] and impaired insulin action due to insulin deficient and/or insulin resistance can cause reduced pancreatic

amylase. Current results suggest that transient high blood glucose, even within the normal response after a meal, can also reduce salivary amylase irrespective of intact insulin action and that such plausible tight mechanism may be applicable to not only pancreatic but also salivary amylase.

In this study, during the first 30 min, a change in blood glucose level (at 15 min) likely proceeded to a change in salivary α-amylase activity. It is noteworthy that the significant correlation between salivary amylase and blood glucose was observed at 1 h after carbohydrate ingestion, but not at fasting, suggesting a possibility that multiple factors including stress or hungry may affect the level of serum salivary amylase in the fasting state [16,17,20], but once blood glucose is elevated, serum salivary amylase level might be restricted in response to the individual's level of blood glucose.

Taken together, these preliminary findings suggest that salivary α-amylase activity is linked to glucose homeostasis possibly through insulin receptors and the sensitivity for blood glucose concentration in the salivary gland. Therefore, although the baseline salivary amylase level may be primarily determined by the *AMY1* gene [11,12], other factors, including glucose homeostasis or dietary factors, might influence the fluctuations of pancreatic and salivary α-amylase activity.

In this study, the effects of proteins or lipids on salivary α-amylase were not examined because of a preliminary study. Otsuki et al. [4] found that serum amylase increased 2h after a high protein diet without changes in blood glucose level in 35 healthy adults aged 26-40 years. Then, although high protein diet is unlikely to elicit reduced salivary amylase, future studies is needed to warrant the effects of kinds of amino acids, lipids, or other nutrients such vitamins and minerals on salivary α-amylase.

In conclusion, this study demonstrates a possible reduction in salivary α-amylase activity after carbohydrate ingestion that was correlated with simultaneous changes in blood glucose levels, suggesting a close link between the activity level of salivary amylase and glucose homeostasis.

Acknowledgment

We wish to thank the staff at the Division of Clinical Nutrition, Department of Medical Dietetics, Faculty of Pharmaceutical Sciences, Josai University, and all the participants for their involvement in this study.

The author has no competing interests to declare and have not received any financial support from pharmaceutical companies.

References

1. Goldstein NP, Smith BW (1949) Effect of the oral administration of glucose upon the concentration of serum amylase in normal adult human subjects. Am J Physiol 159(1): 29-32.

2. Dreiling DA, Janowitz HD, Marshall D, Haemmerli P (1958) Relationship between blood amylase and factors affecting carbohydrate metabolism. I. The regulation of blood amylase level in subjects without pancreatic disease. Am J Dig Dis 3(3): 214-219.

3. Kayashima Y, Iwata K, Hashinaga K (1974) The serum amylase response after oral glucose administration. Iryo 28: 27-33

4. Otsuki M, Yuu H, Yamasaki T, Maeda M, Okano K, et al. (1977) Relationship between serum amylase activity and carbohydrate metabolism in normal persons. Nihonshokakigakaishi 74: 190-196.

5. Skrha J, Srámková J, Rehák F, Pacovský V (1986) Serum isoamylase activities during infusions of glucose and amino acids. Eur J Clin Invest 16(1): 35-38.

6. Panchbhai AS, Degwekar SS, Bhowte RR (2010) Estimation of salivary glucose, salivary amylase, salivary total protein and salivary flow rate in diabetics in India. J Oral Sci 52(3): 359-368.

7. Mandel AL, Breslin PA (2012) High endogenous salivary amylase activity is associated with improved glycemic homeostasis following starch ingestion in adults. J Nutr 142: 853-858.

8. KM P, Johnson P, Ganesh M, Subhashini AS (2013) Evaluation of Salivary Profile among Adult Type 2 Diabetes Mellitus Patients in South India. J Clin Diagn Res 7(8): 1592-1595.

9. Skrha J, Stěpán J (1987) Clinical significance of amylase isoenzyme determination. Acta Univ Carol Med Monogr 120: 1-81.

10. Peyrot des Gachons C, Breslin PA (2016) Salivary Amylase: Digestion and Metabolic Syndrome. Curr Diab Rep 16(10): 102.

11. Perry GH, Dominy NJ, Claw KG, Lee AS, Fiegler H, et al. (2007) Diet and the evolution of human amylase gene copy number variation. Nat Genet 39(10): 1256-1260.

12. Falchi M, El-Sayed Moustafa JS, Takousis P, Pesce F, Bonnefond A, et al. (2014) Low copy number of the salivary amylase gene predisposes to obesity. Nat Genet 46(5): 492-497.

13. Viljakainen H, Andersson-Assarsson JC, Armenio M, Pekkinen M, Pettersson M, et al. (2015) Low Copy Number of the AMY1 Locus Is Associated with Early-Onset Female Obesity in Finland. PLoS One 10(7): e0131883.

14. Zhuang L, Su JB, Zhang XL, Huang HY, Zhao LH, et al. (2016) Serum Amylase Levels in Relation to Islet β Cell Function in Patients with Early Type 2 Diabetes. PLoS One 11(9): e0162204.

15. Yamaguchi M, Deguchi M, Wakasugi J, Ono S, Takai N, et al. (2006) Hand-held monitor of sympathetic nervous system using salivary amylase activity and its validation by driver fatigue assessment. Biosens Bioelectron 21(7): 1007-1014.

16. Maruyama Y, Kawano A, Okamoto S, Ando T, Ishitobi Y, et al. (2012) Differences in salivary alpha-amylase and cortisol responsiveness following exposure to electrical stimulation versus the Trier Social Stress Tests. PLoS One 7(7): e39375.

17. Uesato M, Nabeya Y, Akai T, Inoue M, Watanabe Y, et al. (2010) Salivary amylase activity is useful for assessing perioperative stress in response to pain in patients undergoing endoscopic submucosal dissection of gastric tumors under deep sedation. Gastric Cancer 13(2): 84-89.

18. Korc M, Owerbach D, Quinto C, Rutter WJ (1981) Pancreatic islet-acinar cell interaction: amylase messenger RNA levels are determined by insulin. Science 213(4505): 351-353.

19. Mössner J, Logsdon CD, Williams JA, Goldfine ID (1985) Insulin, via its own receptor, regulates growth and amylase synthesis in pancreatic acinar AR42J cells. Diabetes 34(9): 891-897.

20. Nater UM, La Marca R, Florin L, Moses A, Langhans W, et al. (2006) Stress-induced changes in human salivary alpha-amylase activity-associations with adrenergic activity. Psychoneuroendocrinology 31(1): 49-58.