

The Stress-Induced Cardiovascular Reactivity in the Fasting and Fed States of Healthy Young Indian Males

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ABSTRACT

Background and Objectives: Low blood glucose levels have been associated with a hostile behaviour. The individuals who show aggressiveness and hostility are more likely to develop hypertension and cardiac diseases. The future hypertension has been linked with a high cardiovascular reactivity to stress. We have investigated the association of the blood glucose levels with the Cardio Vascular Reactivity (CVR) to stress.

Methods: Forty six volunteers were subjected to stress (which was induced by the cold pressor task) in the fasting state and again, half an hour after the ingestion of 75 grams of glucose. The CVR in both conditions was compared in terms of an increase in the heart rate and the blood pressure.

Results: The resting pulse was lower and the blood pressure was higher in the fasting condition, as compared to the values which were obtained in the ½ hour post-prandial condition. The CVR to stress was significantly higher in the fasting condition.

Interpretation and Conclusion: The increased resting heart rate and the decreased resting blood pressure in the ½ hour-Post-Prandial (PP) condition was due to the higher levels of histamine in the post-prandial state. Low blood glucose levels are associated with a higher CVR to stress. This suggests that the persons are prone to develop future hypertension, those with frank hypertension, and the chronic pain sufferers should avoid prolonged fasts, in order to lower their CVR to the stress stimuli which are encountered in the daily life.

Key Words: Cardiovascular reactivity, Cold pressor task, Fasting, Stress

INTRODUCTION

An increased Cardio Vascular Reactivity (CVR) to stress has been linked to a future hypertension, which is a risk factor for myocardial infarction, stroke, renal failure, and total mortality [1]. Hypertension and heart diseases have been associated with aggressiveness and hostility [2], which, in turn, have been correlated with low blood glucose levels [3]. No direct comparison has been made between the CVR in fasting and post-prandial conditions.

In this study, we investigated the variations in the CVR to the Cold Pressor Task (CPT), in fasting and half-hour post-prandial (½hr PP) conditions. Two episodes of CPT were performed. The first episode was performed in the fasting condition (with plasma glucose levels between 70-100 mg/dl). The second episode of CPT was conducted half-hour after an oral intake of 75 gram glucose in 300 ml water (with plasma glucose levels of less than or equal to 200mg/dl). Since the blood glucose usually peaks at half an hour after the ingestion of glucose, the second episode of CPT was performed after this time, to obtain a maximum difference in the CVR. Oral glucose was given instead of a regular meal, so that the difference in the CVR could be attributed solely to the increase in the blood glucose levels.

METHODS

Selection of the Volunteers

The protocol of this experimental study was approved by the ethics committee of the Teerthanker Mahaveer Medical College and Research Centre. A convenience sample was selected from among

the student volunteers who were enrolled in the various courses at the Teerthanker Mahaveer University, Moradabad, U.P, India. 72 subjects were selected from among 117 healthy male volunteers (of the age group of 18-25years), who were non-smokers and teetotallers with a Body Mass Index (BMI) of 18.5-24.9 kg/m². The volunteers with a resting heart rate of > 90/min and a resting blood pressure of ≥150/90 mm Hg were excluded from the study, to eliminate the subjects with a pre-experiment sympathetic stimulation.

Written informed consents were obtained from the selected volunteers before the start of the study. The participants were asked to report at 8am, at least 8 hours after the last meal.

Estimation of the Plasma Glucose

2 ml of blood was taken from each subject, 5 min before performing the CPT. Since two episodes of CPT were conducted on each subject (one in fasting and the other in the ½ hours PP condition); blood samples were collected twice from each subject. The plasma glucose was estimated by the O-toluidine method [4]. A sympathetic stimulation occurs as the plasma glucose level falls below 70 mg/dl. Since the sympathetic stimulation is known to increase the CVR, the experimental observations from the subjects with fasting plasma glucose levels of < 70mg/dl were not included in the statistical analysis. This ensured that the increase in the heart rate and the blood pressure, which occurred after the performance of the CPT, was solely due to the sympathetic stimulation which occurred in response to the stress which was induced by the CPT, and not due to the sympathetic stimulation which occurred in response to the low blood glucose levels.

The observations from the subjects with fasting plasma glucose higher than 100 mg/dl and/or with the ½ hour PP plasma glucose higher than 200mg/dl were excluded from the study, as such high glucose levels could have occurred due to an impaired glucose tolerance.

The Method of Performing the Cold Pressor Task

The cold pressor task was performed on each subject in the fasting condition and again, ½ an hour after the ingestion of 75 g glucose in 300 ml water (½ hour PP). CPT was performed as was described by Kumar et al., [5], keeping the time of immersion of the non-dominant hand in a circulating water bath as 2 min. The temperature of the water bath was maintained at 0-1°C. The heart rate and the blood pressure were recorded manually, before and immediately after the performance of the CPT.

On the basis of the plasma glucose levels and the time of immersion, these exclusion criteria were followed:

- The subjects with fasting plasma glucose lower than 70 mg/dl (nine), or more than 100 mg/dl (one).
- The subjects with ½ an hr PP glucose higher than 200 mg/dl (three).
- The subjects with a total time of hand immersion in the cold water bath of less than 90secs during the CPT (thirteen).

Thus, the data analysis was carried out on the observations which were obtained from 46 subjects.

STATISTICAL ANALYSIS

Microsoft Excel 2007 was used to analyze the data. The data which were obtained in the fasting and the ½ an hour PP states were compared by using the Student's t-test. A p-value of <0.05 was considered to be significant.

RESULTS

The observations from the 46 subjects have been summarized in [Table/Fig-1]. Part A of the table shows the basal parameters which were recorded before conducting the CPT. A highly significant rise in the plasma glucose levels was recorded in the ½ an hour PP condition as compared to that which was obtained in the fasting condition. The mean pulse was significantly higher and the mean systolic and diastolic blood pressures were significantly lower in the ½ hours PP condition. Part B of the table has compared the CVR parameters in the fasting and the ½ an hour PP conditions.

Part A: Basal		
Parameters	Fasting	Post-Prandial
Age (Years)	20.44± 2.23	same
BMI (kg/mm ²)	21.61± 2.34	same
W/H Ratio	0.86±0.04	same
PlasmaGlucose (mg/dl)	88.37 ± 8.03	153.35 ±14.08
Pulse (/min)	76.84 ± 7.26	82.51± 6.68
SBP (mmHg)	122.28 ± 9.99	118.05 ±9.33
DBP (mmHg)	81.72 ± 5.83	78.47 ±5.36
Part-B: Cardiovascular reactivity		
dPulse (/min)	8.09 ± 7.47	6.53± 5.97
dSBP (mmHg)	5.58 ± 4.99	3.26 ± 4.21
dDBP (mmHg)	5.86 ± 5.35	4.93 ± 5.40

[Table/Fig-1]: Comparison of Parameters in Fasting and Half-Hour Post-Prandial Conditions

For convenience, only the differences in the pulse (dPulse) and the systolic (dSBP), and diastolic (dDBP) blood pressures, which were obtained on performance of the CPT, have been presented. The dPulse and the dSBP values were significantly lower in the ½ an hours PP condition. Although the dDBP value was lower in the ½ an hours PP condition, the difference was not significant.

DISCUSSION

The increased heart rate and the decreased blood pressure which were observed in the ½ an hours PP condition [Table/Fig-1] were due to the histamine induced post-prandial tachycardia [6] and vasodilatation [7].

This study showed a decreased CVR in the ½ an hours PP condition as compared to that in the fasting condition. The histamine level increases in the PP state, and it has been shown to have an analgesic effect via the H3 receptor [8-10]. Recently, sweet taste-induced analgesia was demonstrated in humans by doing a functional MRI [11]. The decreased pain sensitivity which is produced by the above phenomena may lead to a decrease in the CVR in the ½ an hours post-prandial state.

The decreased CVR in the ½ an hours PP state suggests an intake of frequent small meals by the persons with borderline or frank hypertension, and by the chronic pain sufferers.

CONCLUSIONS

The comparison of the CVR in the fasting and the ½ an hours PP states showed a decreased CVR in the post-prandial state. This suggested that the persons with a high risk for future hypertension should refrain from prolonged fasts, to avoid large fluctuations in the blood pressure in response to small stimuli, which may elevate the risk of a future hypertension.

REFERENCES

- [1] Kasagi F, Masazumi A, Shimaoka K. Relation between cold pressor test and development of hypertension based on 28-year follow-up. *Hypertension*. 1995; 25: 71-76.
- [2] Williams JE, Nieto FJ, Sanford CP, Tyroler HA. Effects of angry temperament on coronary artery disease risk; the atherosclerosis risk in communities study. *Journal of American Epidemiology*. 2001; 154 (3): 230-35.
- [3] Donhoe RT, Benton D. Blood glucose control and aggressiveness in females. *Personality and Individual Differences*. 1999; 26 (5): 905-11.
- [4] Gupta SK, Ghalaut VS, Jain A. In Manual of Practical Biochemistry for MBBS. 2007. Arya Publishing Company.
- [5] Kumar M, Narayan J, Verma NS, Saxena I. Variation in response to experimental pain across the menstrual cycle in women compared with one month in men. *Ind J Physiol Pharmacol*. 2010; 54 (1): 57-62.
- [6] Skovgaard N, Moller K, Gesser H, Wang T. Histamine induces post-prandial tachycardia through a direct effect on cardiac H2-receptors in pythons. *Am J Physiol Regul Integr Comp Physiol*. 2009; 296 (3): R774-85.
- [7] Smith NL, Psaty BM, Rutan GH, Lumley T, Yanez D, Chaves PH, Kronmal RA. The association between time since last meal and blood pressure in older adults: The cardiovascular health study. *J Am Geriatr Soc*. 2003; 51 (6): 824-28.
- [8] Cannon KE, Hough LB. Inhibition of chemical and low-intensity mechanical nociception by activation of histamine H3 receptors. *J Pain*. 2005; 6 (3): 193-200.
- [9] Huang M, Xie YY, Ding GH. Acupoint-injection of histamine induced analgesic effect in acute adjuvant-induced-arthritis rats. *Zhen Ci Yan Jiu*. 2010; 35 (2): 99-103.
- [10] Hasnein P. Effects of histamine H3 receptors on chemical hyperalgesia in diabetic rats. *Neuropharmacology*. 2011; 60 (6): 886-91.
- [11] Kakeda T, Ogino Y, Moriya F, Saito S. Sweet taste-induced analgesia: An fMRI study. *Neuroreport*. 2010; 21 (6): 427-31.

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FINANCIAL OR OTHER COMPETING INTERESTS:

None.

Date of Submission: **Dec 08, 2012**

Date of Peer Review: **Jan 01, 2013**

Date of Acceptance: **Feb 13, 2013**

Date of Publishing: **Apr 01, 2013**