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RESEARCH ARTICLE

THE EFFECT OF COFFEE ON HEART RATE VARIABILITY

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Abstract

Background: Although the effects of coffee on the autonomic nervous system have been well documented, there exists as yet no conclusive data on the effects of the consumption of coffee on heart rate variability (HRV). The objective of this study was to determine the effects of coffee on these parameters among south Indian subjects. **Methods**: This interventional study involved a single group of fifty male subjects aged between 18 and 25. The subjects underwent a set of baseline tests that included recording of the heart rate (HR), blood pressure (BP) and HRV indices. They were then given coffee and fifteen minutes later the same set of tests were performed. **Results:** We observed that coffee significantly increased the HR and systolic BP and reduced the diastolic BP. We noticed an increase in HF power, a reflection of parasympathetic activity, but the increase was not statistically significant .Coffee did not have a significant effect on any of the other HRV parameters. **Conclusions:** We concluded that coffee stimulates the sympathetic nervous system.

Introduction

Coffee, produced from the plant Coffea arabica, is one of the world's most cherished beverages. Caffeine, the principal pharmacological agent present in coffee, is known to affect the autonomic nervous system (ANS). The two divisions of the ANS, the sympathetic and the parasympathetic, work together in a coordinated way so as to regulate visceral functions. Heart rate variability (HRV) is a simple yet reliable tool used to assess cardiac sympatho - vagal activity. Work done so far on the effect of coffee on HRV has been inconclusive, with some studies suggesting an increase in parasympathetic activity (1) and others concluding that coffee had no demonstrable effect on HRV parameters (2). The effects of coffee on the heart rate and blood pressure have been well documented. Coffee is known to increase the heart rate, systolic and diastolic blood pressure. It is pertinent to point out that most studies on the effect of coffee have been conducted on western subjects and that no conclusive data exists on the effects of coffee on HRV.The aim of this study was to determine the effects of caffeine in doses resembling everyday coffee intake on autonomic function in young Indian subjects.

METHODS

Study design and participants

This interventional study was conducted between August 2009 and March 2010 in the Department of Physiology, Pondicherry Institute of Medical Sciences, Pondicherry, south India. Fifty healthy young adult males from the technical staff of the institute volunteered. The subjects were between the ages of 18 and 25 and drank less than 4 cups of coffee or tea or less than two 300 ml bottles of caffeinated soft drinks per day. Individuals with systemic illnesses, sleep disturbances, neuro-muscular disorders, psychiatric illness, peptic ulcer and rhythm abnormalities of the heart were all excluded. Smokers and those who consumed more than 2 units of alcohol per week were also excluded. A written informed consent from the participants and clearance from the institute's research and ethical committees was obtained prior to the commencement of the project.

Procedure

Subjects were instructed to have a light breakfast (less than 250 calories), without coffee or tea at 7a.m. on the morning of the recordings. The recordings commenced at 9a.m. and were performed in a quiet dimly-lit room, with an ambient temperature that varied between 37 and 38°C over the duration of the study. After the subject had rested comfortably for 15 minutes on a

couch, his right radial pulse rate was taken and the blood pressure was recorded on the right arm using a sphygmomanometer (Diamond Company, India). After a further 10 minutes of supine rest a lead II ECG was recorded for 5 minutes under standardized conditions using a computerized ambulatory electrocardiograph system (NIVIQURE, Bangalore, India). Subjects were instructed to close their eyes and to keep still during the recording. The obtained ECG signal, free of ectopics, was amplified, digitized and stored in the computer for offline analysis. A sampling rate of 1024 Hz was used and 256 beats were considered for analysis. This data was then analyzed by the fast Fourier Transformation (FFT) algorithm, and an R-R interval power spectrum was obtained.

Preparation of Coffee

Ten grams of Nescafe Classic instant coffee powder (containing 106 mg of caffeine) and 10gms of sugar were added to 200 ml of boiling water taken in a cup. Milk was avoided so as to prevent the precipitation of compounds. The contents were cooled down to 55°C before being offered to the subject. The subjects were then instructed to drink it within two minutes.

Post-consumption testing

After the baseline tests the subject was instructed to consume the coffee. Fifteen minutes after consumption the same set of tests were repeated in the same order.

Statistical analysis

The results obtained were analyzed using Student's paired't' test for all variables and are expressed below as Mean ± SEM for HRV variables and as Mean ± SD for all the other variables.

RESULTS

The fifty subjects, all male, had a mean age of 20.9 ± 2.8 yrs. The anthropometric measurements of the participants are furnished in table 1. We observed a statistically significant increase ($p<0.0001$) in the heart rate after the consumption of coffee (Table 2). The mean SBP was also seen to increase significantly ($p<0.0001$) after coffee consumption (Table 2). There was however a statistically significant ($p<0.004$) decrease in the mean DBP after coffee consumption (Table 2). The consumption of coffee did not appear to have any statistically significant effect on any of the time domain or frequency domain parameters (Table 3).

Table 1: Anthropometric measurements

Parameter	Before coffee (n=50)
Ht (m)	1.66 ± 0.25
Wt (Kg)	63.66 ± 11.66
BMI (Kg/m2)	22.9 ± 4.2.

All data are expressed as Mean ± standard deviation. Ht: height in meters, Wt: weight in kilograms, BMI: body mass index

Table 2: Effect of coffee on heart rate, SBP and DBP

Parameter	Before coffee (n=50)	After coffee (n=50)	p value
Resting Heart Rate (bpm)	73.02 ± 5.45	77.34 ± 4.42	**p<0.0001**
SBP (mm, Hg)	115 ± 4.08	118 ± 4.22	**p<0.0001**
DBP (mm, Hg)	75.52 ± 2.73	73 ± 2.81	**p<0.004**

All data are expressed as Mean ± standard deviation. Heart rate is expressed as bpm (beats per minute). SBP & DBP: systolic and diastolic BP respectively. The p values were all significant

Table 3: Effect of coffee on HRV

Parameter	Before coffee (mean ± SEM) (n=50)	After coffee (mean ± SEM) (n=50)	p value
SDNN(ms)	83 ± 2.51	86 ± 3.71	0.235
RMSSD (ms)	49.1 ± 3.71	51 ± 4.41	0.531
NN50	32.3 ± 3.26	32 ± 3.71	0.899
pNN50 (%)	12.6 ± 1.27	13 ± 1.41	0.899
LF power (ms^2)	79.17 ± 7.26	74 ± 5.61	0.426
HF power (ms^2)	174 ± 18.72	179 ± 21.7	0.831
LF norm (nu)	34.6 ± 2.27	35 ± 1.97	0.986
HF norm (nu)	65.4 ± 2.27	65 ± 2.01	0.986
LF/HF	0.697 ±0.121	0.608± 0.05	0.418

All values are expressed as Mean ± SEM (standard error of the means)
SDNN-SD of NN interval
RMSSD- Root of the mean of the sum of the squared differences of adjacent NN intervals
NN50 - number of NN interval differences equal to or more than 50 ms
PNN50 (% of NN50)
Low frequency (LF) power
High frequency (HF) power
LF normalized power (LF NORM)
HF normalized power (HF NORM)

DISCUSSION

Caffeine is present in a wide variety of foods and beverages, and is considered to be the most widely consumed naturally occurring drug in the world (3). The effects of coffee on the autonomic nervous system have been well documented. Caffeine exerts its actions on the autonomic system by activating noradrenergic nerves thereby resulting in sympathetic stimulation. (4). In the present study we observed that the mean heart rate was significantly increased after the consumption of coffee, and conclude that this is due to the sympathetic stimulation that caffeine is known to produce. Most other researchers have arrived at similar results (5, 6). Hoffman however found no significant increase in the heart rate after the ingestion of a nutritionally enriched coffee beverage (7). Opinion on the effects of coffee on BP is conflicting. Karatzis, investigating the acute effects of caffeinated and decaffeinated coffee on hemodynamics, found that caffeinated coffee caused a transient but statistically significant increase in both SBP and DBP (8). Hoffman and associates were able to demonstrate that the ingestion of a nutritionally enriched coffee beverage increased the SBP (7). Steinke in a similar study had similar results (5). Lang, in a study involving 6321 adults, was able to demonstrate that the SBP was higher in habitual drinkers of coffee (9). Two cross sectional studies, one conducted in the United States, (10) and the other in Italy (11), both involving hundreds of participants, actually showed an inverse relationship between habitual caffeine consumption and the BP. Salvaggio et al arrived at a similar conclusion in their study that involved more than 9600 participants (12) . However the CARDIA study that involved more than 5000 young adults, who habitually consumed more than 800mg of caffeine per day, was not able to show a definite relationship between caffeine intake and BP (13). In our study we noticed a sharp rise in the SBP and a significant drop in the DBP fifteen minutes after coffee intake. The increase in SBP was probably caused by the sympathetic stimulation that caffeine is known to produce. The transient decrease in DBP we suggest was caused by the thermogenic effect of caffeine which leads to mild peripheral vasodilatation. In recent years researchers have turned to HRV as a tool to assess autonomic function. HRV refers to the beat by beat alteration in heart rate and is a simple but effective method of evaluating the sympatho-vagal regulation of the heart. The source of HRV is a continuous measurement of inter-beat intervals assessed by electrocardiography. HRV is assessed by both time and frequency domain parameters (14). Most of the time domain parameters such as SDNN, RMSSD, NN50 and PNN50 are markers of parasympathetic activity. Among the frequency domain parameters the LF band is a reflection, mainly, of sympathetic activity (15) while the HF band is an indicator of parasympathetic activity. Work done so far on the effect of coffee on HRV has been inconclusive. Some studies seem to indicate that coffee increases HF power implying an increase in parasympathetic activity while others assert that coffee has no demonstrable effect on HRV. It was demonstrated that a cup of espresso coffee containing 75mg of caffeine was able to increase parasympathetic activity (16). In a similar study Hibino observed that there was a transient but significant increase in HF power after consuming a beverage containing 240 mg of caffeine (1). A recent study demonstrated that caffeine increases cardiac vagal activity in healthy middle-aged subjects (17). However Rauh, in a study involving 30 habitual caffeine consumers, concluded that 200mg of caffeine did not produce any perceptible change in HRV within 90 min of ingestion (2). In the present study we noticed a decrease in LF power and increase in HF power. The HRV findings in our study seem to indicate that coffee increases parasympathetic function while causing a concomitant decrease in sympathetic function. The above findings however did not reach significance.

CONCLUSIONS

In conclusion coffee in doses resembling everyday coffee consumption causes a significant increase in the heart rate and SBP while producing a transient but significant fall in the DBP. Coffee does not appear to have a significant effect on any of the HRV parameters.

LIMITATIONS

The present study involved a single group of 50 subjects all of whom were given caffeinated coffee. In retrospect the authors are of the opinion that a placebo – controlled study would have been a better study design.

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