Influence of coffee and caffeine consumption on atrial fibrillation in hypertensive patients

A.V. Mattioli a,1, A. Farinetti b, C. Miloro c, P. Pedrazzi c, G. Mattioli d

a Department of Biomedical Science, Section of Cardiology, University of Modena and Reggio Emilia, Via del pozzo, 71, 41100 Modena, Italy
b Department of Surgery, University of Modena and Reggio Emilia, Modena, Italy
c Section of Nutritional Science, University of Modena and Reggio Emilia, Modena, Italy
d Istituto Nazionale di Ricerche Cardiovascolari, Modena, Italy

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Coffee; Caffeine; Atrial fibrillation; Left ventricular hypertrophy

Abstract  Background and aims: Coffee and caffeine are widely consumed in Western countries. Little information is available on the influence of coffee and caffeine consumption on atrial fibrillation (AF) in hypertensive patients. We sought to investigate the relationship between coffee consumption and atrial fibrillation with regard to spontaneous conversion of arrhythmia. Methods and results: A group of 600 patients presenting with a first known episode of AF was investigated, and we identified 247 hypertensive patients. The prevalence of nutritional parameters was assessed with a food frequency questionnaire. Coffee and caffeine intake were specifically estimated. Left ventricular hypertrophy was evaluated by electrocardiogram (ECG) and echocardiogram. Coffee consumption was higher in normotensive patients. High coffee consumers were more frequent in normotensive patients compared with hypertensive patients. On the other hand, the intake of caffeine was similar in hypertensive and normotensive patients, owing to a higher intake in hypertensive patients from sources other than coffee. Within normotensive patients, we report that non-habitual and low coffee consumers showed the highest probability of spontaneous conversion (OR 1.93 95%CI 0.88–3.23; p = 0.001), whereas, within hypertensive patients, moderate but not high coffee consumers had the lowest probability of spontaneous conversion (OR 1.13 95%CI 0.67–1.99; p = 0.05). Conclusion: Coffee and caffeine consumption influence spontaneous conversion of atrial fibrillation. Normotensive non-habitual coffee consumers are more likely to convert arrhythmia within 48 h from the onset of symptoms. Hypertensive patients showed a U-shaped relationship between coffee consumption and spontaneous conversion of AF, moderate coffee consumers were less likely to show spontaneous conversion of arrhythmia. Patients with left ventricular hypertrophy showed a reduced rate of spontaneous conversion of arrhythmia.

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* Corresponding author. Tel.: +39 59 4224043; fax: +39 59 4224323.
E-mail address: annavittoria.mattioli@unimore.it (A.V. Mattioli).

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Introduction

Coffee is the most widely consumed beverage globally [1]. Although it contains several hundred different substances, effects on the cardiovascular system have mainly been related to caffeine. Caffeine is present in a number of dietary sources and its content ranges from 40 to 180 mg for coffee, 24–50 mg for tea, 15–29 mg for cola, and 1–36 mg for chocolate [1,2]. The relationship between coffee consumption and hypertension has been studied extensively leading to controversial results. Data from cross-sectional studies have suggested an inverse linear or U-shaped relationship between coffee use and blood pressure [3].

Interestingly, the 7th Report of the Joint National Committee (JNC) of the National Heart, Lung and Blood Institute and the 2007 Guidelines for the Management of Arterial Hypertension did not mention coffee intake in lifestyle modifications [4,5]. Moreover, the recently published ASH position paper on dietary approaches to lower blood pressure avoids including coffee consumption in the analysis, mainly because of the controversial results reported in different studies [6].

Prospective studies have suggested a protective effect of high coffee intake against hypertension, mostly related to antioxidant properties [7]. The hypothesis that components in coffee may lower the risk of cardiovascular disease is supported by a recent study evaluating a large cohort of women, showing that those who drank moderate to high amounts of coffee had a lower risk of stroke than those who did not consume coffee. This association was only partially mediated by potential biological mediators [8]. Little information is available on the relationship between coffee and caffeine consumption and atrial fibrillation (AF) in hypertensive patients, although AF is the most common arrhythmia in hypertension.

This study was designed to evaluate the influence of coffee and caffeine intake on spontaneous conversion of acute AF in hypertensive patients.

Methods

Patient population

The study group included 600 patients, 381 men and 219 women of mean age 59 ± 11 years, presenting with first-detected AF. We identified 247 patients with a previous diagnosis of Stage I hypertension.

Hypertension was defined according to recommendations in the 7th Report of the JNC of the National Heart, Lung and Blood Institute which classifies Stage I hypertension as a systolic blood pressure (SBP) of 140–159 mmHg or a diastolic blood pressure (DBP) of 90–99 mmHg [4]. For all patients, we recorded the three most recent outpatient blood pressure measurements before hospitalization and from these, calculated the average achieved SBP and DBP. Patients with Stage II hypertension were excluded from the study.

Inclusion criterion was the first-detected episode of AF occurring within 6 h of observation. According to recent ACC/AHA/ESC Guidelines for the Management of Patients with Atrial Fibrillation, first-detected AF may be either paroxysmal or persistent AF [9]. Exclusion criteria were permanent AF, any condition predisposing patients to AF such as history of myocardial infarction, heart failure, rheumatic heart disease, and a reduced ventricular function.

The onset of AF was defined as a new and clearly recognizable onset of symptoms including palpitations, dyspnea or dizziness. The diagnosis was confirmed by electrocardiogram (ECG). Patients were evaluated and telemetry monitoring technicians notified the investigators as soon as normal sinus rhythm was restored and electrocardiographic rhythm strips had been obtained. The Ethics Committee of our University approved the study protocol and informed consent was obtained from all participants.

If the physician decided that cardioversion was required, it was performed within 48 h from the first observation of arrhythmia. Anticoagulant therapy was started before cardioversion.

Data collection

Left ventricular hypertrophy (LVH) was assessed by ECG. The presence of increased voltage was calculated using the modified Cornell criteria. These criteria are, for men, S in V3 + R in aVL N2.8 mV [28 mm], and, for women, S in V3 + R in aVL N2.0 mV [20 mm] [10].

Nutritional data were collected, assessed as weight, body mass index (BMI), waist circumference and waist-to-hip ratio. BMI was calculated by dividing the participant’s weight by measured height squared.

The prevalence of nutritional parameters was assessed by a self-administered food frequency validated questionnaire (FFQ) with 116 items [11,12]. The food list in the FFQ was modified for an Italian diet, and foods commonly eaten in the Emilia Romagna region of Italy were added. For each food class, color photographs of three different portions were displayed. Portion sizes were chosen according to many years of experience in dietary surveys in various parts of Italy [13]. Coffee consumption was specifically estimated as: number of cups of coffee, type of coffee (espresso, American, decaffeinated, cappuccino), number of chocolate snacks usually consumed. Food frequency was evaluated using three categories: daily, weekly and monthly and with amounts from 1 to 6 (i.e. once a day, three times a week) and was integrated with specific questions on changes in coffee intake and lifestyle within the last year and specifically during the 3 days before the onset of symptoms.

We estimated caffeine intake as 1 cup of espresso coffee = 90 mg, 1 cappuccino = 110 mg, 1 cup of American coffee = 160 mg, 1 can of cola soda = 42 mg and one chocolate snack = 6 mg [2,14]. Coffee intake was divided into four categories: low habitual (from 1 cup/day), medium habitual (2–3 cups/day), heavy habitual (more than 3 cups/day) and non-habitual (0 cups/day).

Food and nutrient intakes from FFQ were computed by a dietician using the same database system. The nutrient database was compiled from food composition tables [13].

Alcohol intake, smoking and physical activity were investigated. Physical activity was assessed with a self-administered questionnaire that has been shown to be valid and reliable [15].
Statistical analysis

SPSS, V.11.0.1 (SPSS Inc, Chicago, Ill, USA) was used for statistical analysis. Results are presented as mean ± standard deviation (SD) or frequency expressed as a percentage. We compared the characteristics of patients with and without hypertension by the Student’s t-test for continuous variables and chi-squared test for proportions. Associations between variables and coffee consumption groups of patients were evaluated using analysis of variance (ANOVA). Associations between categorical variables and coffee drinking groups were evaluated using the chi-squared test. Using an ANOVA test, univariate regression analysis was performed on the list of predictor variables in patients with spontaneous conversion of AF compared with patients who did not have spontaneous conversion of arrhythmia and p < 0.05 was considered statistically significant. All candidate predictors with a univariate p < 0.15 were evaluated for independent association in a backward stepwise logistic model. Moreover, with the calculation of odds ratio and the corresponding 95% confidence intervals, multiple logistic regression analysis was used to evaluate the association between coffee intake and spontaneous conversion of atrial fibrillation. Continuous variables were standardized to 1 SD to determine the magnitude of the relationship to, and the statistical significance of the predictors of each of the defined outcomes in the regression analyses.

Results

Clinical characteristics of the patients are shown in Table 1. Hypertensive patients were treated with different drugs. Forty-five patients were treated with angiotensin-converting enzyme (ACE)-inhibitors, 44 patients with beta-blockers, 124 were treated with diuretics alone (45) or associated with other drugs, 87 patients were treated with angiotensin receptor blockers, 43 patients were treated with calcium channel blockers, and 23 patients were treated with more than two drugs. The mean duration of hypertension was 27 ± 9 months.

Patients categorized as coffee consumers reported that they had consumed coffee for at least 25 years of their life. Men were heavier coffee consumers than women (p < 0.05).

High coffee consumers were more frequent in the group of normotensive compared with hypertensive patients (mean: 4.1 ± 1.4 vs 1.97 ± 1.0 cups/day, p < 0.001). On the other hand, the intake of caffeine was similar in normotensive and hypertensive patients, owing to a higher intake of caffeine from sources other than coffee. Hypertensive patients were more likely to be non-coffee drinkers and decaffeinated coffee drinkers (12% vs 5% of normotensive patients). As self-reported, caffeine intake increased on the 3 days before the onset of AF (Fig. 1). The increase in coffee consumption was more marked in hypertensive patients, non-habitual and low coffee drinkers. The intake of snacks and chocolate was more marked in hypertensive patients leading to an increase in caffeine (Fig. 2).

Spontaneous conversion of AF within 24 h occurred in 189 patients (31.5%); 55 patients (22.2%) belonged to the hypertensive group. In the logistic regression analysis, the presence of spontaneous conversion to sinus rhythm was used as the dependent variable. Independent variables were indicator variables representing hypertension, LVH, levels of coffee consumption, levels of caffeine intake, physical activity and BMI.

Normotensive patients (OR 3.1 95%CI 1.98–5.5; p < 0.001) had the highest probability of spontaneous conversion. Alcohol consumption, physical activity and smoking did not influence spontaneous conversion of AF.

Due to the well-known influence of hypertension as a negative predictive factor for conversion of AF, the analysis was then performed separately in hypertensive and normotensive patients.

Analyzing normotensive patients according to category of coffee consumption, non-habitual and low coffee consumers showed the highest probability of spontaneous conversion (OR 1.93 95%CI 0.88–3.23; p = 0.001).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Clinical and demographic characteristics of patients included in the study.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical characteristics</td>
<td>Hypertensive patients</td>
</tr>
<tr>
<td>Number of patients</td>
<td>247</td>
</tr>
<tr>
<td>Mean age (years ± SD)</td>
<td>54 ± 10</td>
</tr>
<tr>
<td>Gender (male/female)</td>
<td>135/112</td>
</tr>
<tr>
<td>Body mass index (mean ± SD)</td>
<td>29.9 ± 5.6</td>
</tr>
<tr>
<td>Waist-to-hip ratio</td>
<td>0.99 ± 0.1</td>
</tr>
<tr>
<td>Heart rate (beats/min, mean ± SD)</td>
<td>70 ± 20</td>
</tr>
<tr>
<td>Left atrial diameter (mm, mean ± SD)</td>
<td>46 ± 6</td>
</tr>
<tr>
<td>Left atrial maximal volume (ml, mean ± SD)</td>
<td>32 ± 4</td>
</tr>
<tr>
<td>LV end-diastolic volume (ml, mean ± SD)</td>
<td>126 ± 7</td>
</tr>
<tr>
<td>LV ejection fraction (% , mean ± SD)</td>
<td>53 ± 5</td>
</tr>
<tr>
<td>Physical activity (sedentary, %)</td>
<td>111 (45%)</td>
</tr>
<tr>
<td>Marital status (married, %)</td>
<td>185 (75%)</td>
</tr>
<tr>
<td>Marital status (divorced, %)</td>
<td>54 (21.8%)</td>
</tr>
<tr>
<td>Alcohol intake (abstainer, %)</td>
<td>52 (21%)</td>
</tr>
<tr>
<td>Smoking (never, %)</td>
<td>60 (24%)</td>
</tr>
<tr>
<td>Smoking (past, %)</td>
<td>62 (25%)</td>
</tr>
</tbody>
</table>

LV = left ventricular.
In the group of hypertensive patients, the prevalence of spontaneous conversion of arrhythmia was lower in the moderate coffee consumption group compared to no intake or high intake groups. Age- and sex-adjusted logistic regression analysis revealed that moderate coffee drinking was associated with 1.13 times lower odds of spontaneous conversion of AF (95%, CI 0.67–1.99), while no significant associations were observed between the other coffee intake categories. The analysis was adjusted for various other potential confounders, such as age, sex, physical activity status, smoking habits, BMI, and the presence of LVH (Table 2).

Compared to non-consumption, the multi-adjusted odds ratio of spontaneous conversion was 0.37 (95%, CI 0.35–0.69) for 1 cup/day, while it was 1.01 (95%, CI 0.70–1.62) for three or more cups/day, indicating that only moderate coffee drinking was associated with a lower likelihood of spontaneous conversion of AF after adjusting for various potential confounders (Table 3).

**Discussion**

The main finding of the present study is that hypertensive patients who were moderate coffee consumers had the lowest probability of spontaneous conversion of AF, whereas non-habitual, low coffee consumers and high coffee consumers had a higher probability of spontaneous conversion of arrhythmia.

To the best of our knowledge, there have been no prior studies evaluating the relationship between coffee and caffeine intake and the risk of AF in hypertensive patients. Coffee consumption was higher in normotensive compared to hypertensive patients. Many hypertensive patients reported that they had switched to decaffeinated coffee because of their diagnosis and that they avoid coffee as a source of caffeine as part of their lifestyle. Our observation that hypertensive patients had an increase in caffeine intake but not in coffee consumption supports this hypothesis. This effect depends on the self-limitation of coffee consumption whereas there is a smaller limitation to

| Coffee, low, 1 cup/day vs none | −4.1 ± 4.4 | 0.32 |
| Coffee, medium, 2 cups/day vs none | 15.4 ± 3.4 | 0.001 |
| Coffee, heavy, >3 cups/day vs none | −3.2 ± 6.4 | 0.41 |
| Age (per 1 year) | −0.56 ± 1.4 | 0.09 |
| Male (yes/no) | 5.3 ± 6.4 | 0.44 |
| LVH (yes/no) | −1.3 ± 0.46 | 0.05 |
| Smoking (yes/no) | 3.3 ± 3.4 | 0.32 |
| BMI (per 1 kg/m²) | 0.9 ± 1.1 | 0.07 |

BMI, body mass index; LVH, left ventricular hypertrophy; SE, standard error of the beta coefficient.
other sources of caffeine owing to the limited knowledge of food composition. The self-limitation of coffee consumption is not supported by unanimous evidence that it decreased blood pressure [16,17]. In a meta-analysis evaluating coffee and caffeine trials separately, blood pressure elevation in caffeine trials appeared to be greater when compared to coffee trials [18]. The effect of coffee on blood pressure could also depend on brewing method; the strongest effect was found for boiled coffee [18]. We evaluated espresso coffee consumption since this is the most popular type of coffee in Italy, whereas other types of coffee are not really widespread.

In previous papers, we found that acute life stress induced changes in lifestyle, specifically in nutrition habits [12,19]. Hypertensive patients self-reported an increase in coffee consumption in the 3 days before the onset of AF suggesting a role of acute caffeine intake in inducing the arrhythmia. Although normotensive patients had a higher intake of coffee compared to hypertensive patients, the caffeine intake was similar in the two groups, due to caffeine intake from sources other than coffee. Since caffeine acts directly on pathways of autonomic control, we can hypothesize a synergistic effect of caffeine in inducing AF. The autonomic system impairment is prominent in non-habitual coffee consumers due to the rapid tachyphylaxis of caffeine in habitual consumers [20,21]. We hypothesized that the sudden increase in caffeine intake could act as a trigger for AF. The high rate of spontaneous conversion in patients with a normal heart suggests a transient activation of the sympathetic system triggered by increased caffeine intake.

In hypertensive patients, this relationship between acute increase in caffeine intake and high rate of spontaneous conversion of arrhythmia was not linear. We reported an inverse U-shaped relationship between coffee consumption and conversion of AF. We propose that several factors influenced the conversion of AF in hypertensive hearts.

In the present study, patients with LVH were less likely to experience spontaneous conversion of AF. The risk of AF increases with left ventricular mass, LVH is associated with greater diastolic dysfunction and with higher left atrial (LA) volumes and atrial remodeling [22,23]. There is substantial evidence to support the fundamental role of LA remodeling in the cascade of events leading to the development of persistent AF [24]. In a previous study, we found that LVH had a greater influence on LA remodeling with respect to duration of AF [23]. This feature suggests that the relationship between LVH, left atrial size and AF is complex and further studies are required.

Limitations of the study

The present analysis is based on a self-reported food frequency questionnaire, not on objective collection of data from dieticians, which limits the accuracy of coffee intake assessment. Second, the exact number, duration, and timing of asymptomatic AF episodes, as well as the frequency and type of onset triggers were unknown. Thus, it was impossible to include patients with occult intermittent AF.

Finally, due to the low number of hypertensive patients and the wide range of antihypertensive drugs used, we did not find a significant influence of antihypertensive drugs on AF. ACEI-based and angiotensin receptor blocker (ARB)-based therapy has been shown to reduce the relative risk of new-onset AF. However, this benefit mainly occurred in patients with heart failure. In patients with hypertension, no significant reduction in new-onset AF was documented (relative risk reduction 12%; \( p = 0.4 \)). On the other hand, the LIFE study clearly demonstrated that, in the presence of LVH and hypertension, ARB treatment significantly reduced the incidence of AF by 29% [25]. This topic is controversial and we cannot exclude a relationship between antihypertensive drugs and AF.

Conclusions

Normotensive patients were more likely to develop spontaneous conversion of AF, whereas hypertensive patients with LVH were less likely to spontaneously convert the arrhythmia. Hypertensive patients showed a U-shaped relationship between coffee consumption and spontaneous conversion of AF. Patients with LVH who were moderate coffee consumers tended to persistence of AF. Coffee consumption was higher in normotensive patients with AF compared with hypertensive patients, however caffeine intake was similar in the two groups due to higher intake from other sources.

Coffee and caffeine seem to influence the development and spontaneous conversion of AF in hypertensive patients, suggesting that an accurate analysis of lifestyle could be useful to identify patients with a greater risk of persistence of AF. An intervention on lifestyle in hypertensive patients may prevent the onset of AF and negative atrial remodeling. Further information on dietary sources of caffeine would result in a reduction in AF episodes triggered by caffeine.

Conflict of interest

None declared.

Appendix

Supplementary material

Supplementary data associated with this article can be found in the online version, at doi:10.1016/j.numecd.2009.11.003.
References


