J Neurol (2009) 256:488–492
DOI 10.1007/s00415-009-0118-9

ORIGINAL COMMUNICATION

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Chocolate consumption is increased in Parkinson's disease

Results from a self-questionnaire study

Received: 4 July 2008
Received in revised form: 22 August 2008
Accepted: 26 September 2008
Published online: 13 March 2009

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Abstract Clinical observations in Parkinson's disease (PD) patients suggested an increased chocolate consumption. Chocolate contains high contents of various biogenic amines potentially influencing brain monoamine metabolism. 498 PD patients and their partners were evaluated by a structured self-questionnaire asking for consumption of chocolate and non-chocolate sweets, changes in chocolate consumption during the disease course, and depressive symptoms. Questionnaires from 274 patients (55 %) and 234 controls were eligible for further analysis. Consumption of chocolate was significantly higher in PD patients compared to controls, while consumption of non-chocolate sweets was similar in both groups. Our study suggests that chocolate consumption is increased in PD independent of concomitant depressive symptoms measured by BDI-1. Although reasons for increased chocolate consumption in PD remain elusive, it may hypothetically be a consequence of the high content of various biogenic amines and/or caffeine analogues with potential antiparkinsonian effects.

Key words Parkinson's disease · chocolate · biogenic amines · self-questionnaire

Introduction

Chocolate consumption has long been associated with enjoyment and pleasure. Popular claims confer on chocolate the properties of being a stimulant, relaxant, euphoriant and antidepressant. These possible pharmacological actions might be related to various biogenic amines, such as serotonin, dopamine, tyramine, histamine, β-phenylethylamine [10] and cannabinoid-like substances [3]. Most amines are metabolized by monoaminoxidase-A (MAO-A) and are therefore unable to pass the blood-brain barrier. In contrast, β-phenylethylamine is a direct dopamine releasing ingredient and as a substrate of MAO-B and due to its lipophilic structure even capable to pass the blood-brain barrier. In addition, cacao and thus chocolate contain caffeine and several of its structural derivatives with potential antiparkinsonian effects [1, 6]. Within this line, our own clinical observations suggested an increased chocolate consumption in patients with Parkinson's disease (PD) compared to healthy subjects and to their pre-disease state. We therefore assessed the consumption of chocolate and non-chocolate sweets in PD patients and their partners (as household controls) using a self-questionnaire and correlated the results with concomitant diseases, particularly depression.

Methods

Study and questionnaire design

We selected all patients from the clinical information database of our Department of Neurology, who consulted us between January 2005 and January 2007, and had been diagnosed with PD according to the UK Brain Bank criteria [5]. We sent these patients a structured self-

JON 3118

questionnaire designed for PD patients and another one designed for healthy controls to be filled out by their partners. The study was approved by the ethical committee at the Dresden University of Technology (EK no. 56032006). The questionnaire for the patients included questions on demographic data (PD characteristics, depression, medication and concomitant diseases), the actual daily chocolate and non-chocolate sweet consumption, and changes of chocolate and non-chocolate sweet consumption during the disease course. The questionnaire for healthy controls was completely identical except that questions on the disease and changes in consumptions within the disease course were omitted. All subjects were asked for depression in their medical history and requested to fill out Beck's Depression Inventory (BDI-1) [4]. According to the obligations of the EC board, we asked the patients to return their questionnaires anonymously.

Statistical analysis

Statistical analysis was performed with SAS software (version 9.1). Data are presented as raw mean ± standard deviation (SD) and range. Analysis of normality was performed with the normal probability–quantile plot. Statistical comparisons between both study populations (patients who returned vs. patients who did not return the questionnaires) to analyze potential recall biases were not possible (due to anonymously returned questionnaires), and we therefore compared the responder subpopulation with the whole study population (all patients who were sent a questionnaire). The analyses were based on two methods: i) Simple statistical tests (t-test, Mann-Whitney U-test and Chi-square test corresponding with the scaling of the variable) without consideration of similarities of behavior in each family, and ii) test of the patient-relative factor in linear models of the covariance analysis under consideration of correlated residuals for persons from identical families (only for approximate normal distributed variables). In the linear models, possibly confounding variables age, gender and BDI were used as linear covariables.

Results

Study population

We addressed 498 PD patients and their partners with the self-questionnaire. Questionnaires from 274 patients (55 %) and 234 controls were returned and eligible for further analysis. There were no significant differences between the whole addressed patient population and the responder subpopulation with respect to age (mean age: 67.3 years, 95 % CI: 66.3–68.3 years, for whole study population; mean age: 66.2 years, 95 % CI: 65.1–67.2 years, for responder subpopulation) and gender (37.3 % males in the whole study population versus 34.7 % in the responder subpopulation; $P = 0.402$). Demographic and background characteristics of both responder groups (patients and their partners) are summarized in Table 1. PD patients were slightly, but significantly older compared to their partners ($P = 0.0142$) and there were more males in the patients group compared to the control group ($P < 0.0001$). In contrast, there were no statistical differences regarding the coincidence of diabetes mellitus or gastrointestinal disorders between the two groups (Table 1). Depression in medical history was significantly more frequent in PD patients than in their partners (24 % vs. 10 %; $P < 0.0001$; Table 1). Consistently, total BDI scores were significantly higher in PD patients (2.3 ± 2.7; $n = 245$) compared to controls (1.3 ± 1.7; $n = 208$; $P < 0.0001$).

Chocolate and non-chocolate sweets consumption

The weekly consumption of chocolate was significantly higher in PD patients compared to household controls (Table 1). In contrast, there were no differences regarding the weekly consumption of non-chocolate sweets. Although group differences for age, gender and BDI score between the two groups had confounding influence on chocolate consumption when analyzed by linear model of covariance analysis, we found an independent influence of PD on chocolate consumption (Table 2). Frequency of depression, concomitant diseases (diabetes mellitus) and medication had no significant influence on chocolate consumption in this statistical model. Stepwise deletion of relevant confounding variables confirmed the independent influence of PD on chocolate consumption in all models. Due to highly variable combinations of antiparkinsonian drugs in most patients (11 (4.0 %) of patients took no medication, 76 (27.7 %) one compound, 70 (25.5 %) two, 74 (27.0 %) three and 43 (15.7 %) four or more compounds in various combinations, see Table 1 for details), our data set did not allow valid statistical correlations of chocolate intake and certain antiparkinsonian drugs.

In the PD group, 60 patients (22 %) reported increased consumption of chocolate during the disease course (Table 1), while only 11 patients (4 %) reported an increased consumption of other sweets (data not shown; $P < 0.0001$). There was no correlation between chocolate consumption and age in the two groups (Pearson correlation coefficients: –0.085 [$P = 0.222$] and –0.045 [$P = 0.594$] for PD and controls, respectively) or disease duration (Pearson correlation coefficient: 0.073; $P = 0.312$).

Discussion

Our self-questionnaire study provides first evidence that consumption of chocolate is increased in PD patients compared to household controls. This effect seems to be specific for chocolate and independent of concomitant conditions such as depression and diabetes mellitus and is not observed with non-chocolate sweets.

The reasons for increased chocolate consumption remain elusive and our self-questionnaire study was not designed to investigate the factors underlying this observation. However, our data shed some light on possible factors contributing to increased chocolate consumption in PD. It is well known that poor mood stimulates the eating of "comfort foods" such as chocolate and that

Table 1 Characteristics of the study subjects

Characteristic	PD patient group	Household control group	P Value
No. of subjects	274	234	
Male sex (no., %)	179 (65.3 %)	69 (29.5 %)	< 0.0001[c]
Age (years)	66.2 ± 8.4 (33–86)	64.2 ± 8.8 (33–86)	0.0142[d]
Disease duration (years)	9.2 ± 6.6	–	
BDI-1 score	2.3 ± 2.7 (0–18)	1.3 ± 1.7 (0–10)	< 0.0001[e]
Medication			
Levodopa therapy (no., %)	182 (66.4 %)	1 (0.4 %)[f]	–
Dopamine agonists (no., %)	189 (69.0 %)	1 (0.4 %)[f]	–
Other antiparkinsonian agents (no., %)	148 (54.0 %)	1 (0.4 %)[f]	–
Antidepressants (no., %)	38 (13.9 %)	6 (2.6 %)	< 0.0001[c]
Concomitant diseases[a]			
Diabetes mellitus (no., %)	27 (9.9 %)	21 (9.0 %)	0.735[c]
Gastrointestinal diseases (no., %)	20 (7.3 %)	15 (6.5 %)	0.693[c]
Depression (no., %)	66 (24.1 %)	23 (9.8 %)	< 0.0001[c]
Sweet consumption			
Chocolate consumption (grams per week)	100.3[94.5] ± 105.3 (0–600)	57.3[63.6] ± 78.1 (0–700)	< 0.0001[e]
Non-chocolate sweet consumption (grams per week)	207.1[208.15] ± 206.9 (0–1560)	192.5[185.00] ± 184.0 (0–1110)	0.4542[e]
Changes of chocolate consumption[b]			
Increased (no., %)	60 (33.9 %)	–	–
No change (no., %)	110 (62.1 %)	–	–
Decreased (no., %)	7 (4.0 %)	–	–

Plus–minus values are means ± SD, values in squared brackets are adjusted means, values in parentheses are ranges. *BDI-1* Beck's Depression Inventory version 1, higher scores indicate a greater severity of depressive symptoms
[a] Concomitant diseases in medical history
[b] Changes of chocolate consumption during the disease course (data from only 177 patients)
[c] Chi-square test
[d] Unpaired t-test
[e] Mann-Whitney U-test
[f] Treatment with antiparkinsonian medication was due to restless legs syndrome in these control probands

Table 2 Statistical tests considering families

Sweet consumption	P values				Regression coefficient		
	Patient – spouse/partner	Age	Gender	BDI	Age	Gender	BDI
Chocolate consumption	0.0012	0.0006	0.0240	0.0270	–1.704	20.899	4.258
Non-chocolate consumption	0.1573	0.2127	0.0274	0.0067	1.4069	–35.4306	10.8711

Results are from linear models of the covariance analysis under consideration of correlated residuals for persons from the same households (families)

depression increases craving for sweets [8]. As expected from several previous reports [14], the frequency and severity of depression were significantly higher in our PD population compared to the control group with a frequency similar to other studies using self-questionnaires [12, 13]. However, statistical analysis showed no influence of both BDI-1 score and frequency of depression on chocolate consumption in the two study groups. This observation is in agreement with the view that chocolate may provide only some transient "comforting" benefits in depressive patients [9].

PD patients suffer from progressive weight loss during the disease course with lower body mass indexes compared to healthy subjects and consistently tend to increase their energy intake [2]. Although we were not able to measure body weight or even changes in body weight or energy intake, our findings do not support the hypothesis that increased chocolate consumption in PD is for compensation of energy deficits: (i) We did not find any correlation between the amount of consumed chocolate and disease duration, and (ii) the effects were specific for chocolate and not observed with other high energy-containing sweets.

Since PD is associated with impaired olfactory function [7], increased chocolate consumption might be a consequence of changes in psychophysical responses to

chocolate taste stimuli. However, Sienkiewicz-Jarosz and colleagues did not find relevant alterations in taste responses to chocolate in PD compared to controls [11]. Another possible reason for the increased chocolate consumption in PD patients might be the high content of biologically active compounds with potential antiparkinsonian effects in cocoa and thus chocolate, such as caffeine and its structural analogous [1] and/or various biogenic amines, such as dopamine, serotonin and β-phenylethylamine [10]. Most of these amines are metabolized by MAO-A and are therefore unable to pass the blood-brain barrier. In contrast, β-phenylethylamine is a direct dopamine releasing ingredient and interestingly as a substrate of the MAO-B and due to its lipophilicity even capable to pass the blood-brain barrier. Caffeine and its structural analogues are also considered as substances with mild antiparkinsonian effects via inhibition of adenosine A2A receptors [6]. On the other hand, increased chocolate consumption in PD might be a consequence of its specific reward by satisfying cravings similar to hedonistic reward in depression [8, 9]. Our study is, however, not able to differentiate between chocolate craving and "therapeutic eating" in order to compensate the parkinsonian disease state.

Our study has several limitations: First, we used a self-questionnaire to evaluate chocolate consumption without the possibility to confirm the results and to objectively measure parameters such as body weight, depression or parkinsonian symptoms.

Second, we can not exclude a recall bias with a response rate of 55 %. Due to obligations of our local ethics committee, we strongly asked our patients to respond anonymously and thus only comparisons between the whole patient population and the responder subpopulation were possible. However, we did not find any significant differences between the two populations concerning age and gender.

Third, we chose PD patients treated in a specialized university-based department which might lead to relevant selection biases. However, we asked all patients in a defined period of time to participate to largely exclude biases. In addition, our study population showed demographic characteristics very similar to other clinical trials in PD including a frequency of depression of approximately 24 % of patients [12, 14].

Fourth, the two study groups showed significant differences with respect to gender and age. This is due to both the composition of our control group consisting of the spouses/partners of the patients and the possible slightly higher incidence of PD in males [15], with higher percentages of males in most clinical studies in PD. Due to practical issues of a self-questionnaire study, we used a household control which can be considered a weak control population in studies on eating habits.

Fifth, the PD patient group displayed higher frequency and severity of depressive symptoms compared to controls, which might have influences on consumption of chocolate with potential antidepressive effects. Consequently, we used statistical methods to exclude age and depression as relevant confounder variables.

Our study provides first evidence for higher chocolate consumption in PD, an observation specific for chocolate and not found with other sweets and independent of concomitant conditions. However, future studies are warranted to verify our observations in a controlled and prospective manner, and to explore the underlying mechanisms for increased chocolate consumption among PD patients.

Conflict of interest The authors declare no conflict of interest.

Acknowledgments We thank Peter Riederer, University of Würzburg, for intensive discussions on biogenic amines and their potential effects in PD. This study was supported by a grant form the Research Foundation of the Medical Faculty at Dresden University of Technology.

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