Effects of nibbling and gorging on lipid profiles, blood glucose and insulin levels in healthy subjects

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ABSTRACT

Objective: Although there is some evidence indicative of some beneficial effects of an increased meal frequency on the lipid profiles, the results published are controversial. The aim of the present study is to investigate the effects of feeding frequency on blood lipids, glucose and insulin.

Methods: The subjects of this study were 15 healthy non-smoker males aged 27.2 ± 6.4 years. All subjects were placed on 2 identical diets in which they consumed the same food either as 3 meals at 7-hours intervals (gorging diet) or as 9 snacks at 2 hours intervals (nibbling diet). Each diet was of 2 week's duration and was separated from each other by a period of 3 weeks. At the end of both diets, the plasma was obtained from fasting blood samples and its lipid levels were determined. The study was carried out in Tabriz University of Medical Sciences, Tabriz, Iran between 30 October 1998 and 19 December 1998.

Results: The nibbling diet was associated with an increased level of glucose ($p<0.01$) and a decreased level of insulin ($p<0.05$). The plasma levels of total cholesterol, triglyceride, low-density lipoprotein, and lipoprotein (a) were found to be lower in the end of nibbling diet compared with the gorging diet, however, only for the last parameter this reduction was significant ($p<0.02$). The nibbling diet resulted in an insignificant increase in the high-density lipoprotein concentration.

Conclusion: Taking into account, the difficulty in following the nibbling diet with a fear of weight gain, there would be no advantages in recommending the nibbling dietary pattern for normal free-living subjects, although its metabolic benefits in obese people could be the subject for further studies.

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Human eating behavior depends on not only biological but also cultural and social aspects, and the nature and range of food variety, ways of preparing food, the norms of consumption and social conventions of the time or quantity of meals are extremely affected by cultural and social factors.[1] One of these behaviors is meal frequency whose number, time, the quantity and quality of foods eaten in each meal may differ markedly from one society to another. According to some studies, eating frequency could alter some of the main biochemical parameters and metabolic processes. The earlier reports concerning metabolic consequences of eating frequency in normal subjects were published in 1960s,[2-4] although studies in the effects of feeding frequency on diabetics return to more than 50 years ago.[5] These results together with some other results published later[6-8] were indicative of the beneficial effects of increased meal frequency (nibbling dietary regimen) on lipid profiles and carbohydrate tolerance compared with 2 or 3 meal diet (gorging dietary regimen). Based on these results, it has been suggested that nibbling diet is associated with lower concentrations of total cholesterol,

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low-density lipoprotein (LDL-C), apolipoprotein B, insulin and consequently, a reduced risk of cardiovascular diseases.[6,7,9-11] However, these studies suffer from some weak-points such as limited period of experimental dietary regimens, deficiency in quantifying the number of meal frequency, the lack of an accepted definition of an eating occasion, variety of methods used and the exact nature of the dietary intervention.[12,13] In addition, the results reported are insufficient and sometimes controversial.[13-16] Murphy et al[13] have not found significant differences in fasting or postprandial plasma concentrations of triacylglycerol, non-esterified fatty acids, glucose, and also in fasting total cholesterol or LDL-C levels in response to the standard test meal following the nibbling (12 meals per day) or gorging (3 meals per day) dietary regimes. However, in contrast to Murphy et al,[13] Arnold et al[16] have reported a reduction in HDL-lipoprotein (HDL-C) on 9 meals regime compared with a 3 meals regime. According to some other authors,[14,15] alteration of meal frequency dose not resulted in significant differences in the concentrations of fasting lipids of normolipidemic individuals. In the present comparative study, the effects of nibbling and gorging diets on lipid profiles, blood glucose and insulin levels in normal subjects are investigated.

Methods.

Subjects. The subjects of this study were 15 healthy normolipidemic and non-smoker males with an average age of 27.2 ± 6.4 years and a mean body weight of 66.8 ± 11.1 kg.

Dietary program. All 15 subjects were placed on 2 identical diets with a calculated energy intake of 2300 kcal/day. During the first diet, the subjects consumed their daily foods as 9 snacks at 2 hours intervals starting from 7 o'clock (nibbling diet). Following a 3 weeks wash-out period when the volunteers followed their usual diets, all subjects switched to the second diet consist of 3 meals with an equal energy consumed by each subject at 7, 14 and 21 o'clock (gorging diet). Each diet was of 2 weeks'duration. Subjects were given the relevant information on the dietary protocols in the beginning of both diets, and a diet sheet including the dietary tables was given for all subjects. The food intake for both diets was planned and formulated by nutritionist to give 2300 kcal/day energy consists of 35% calories as fats, 55% calories as carbohydrate, and 12% calories as protein. The volunteers were asked to do ordinary physical activities during the study. Dietary intake during the study was assessed by 3, 24-hour dietary recalls recorded for each subject and data analysis was carried out using Nutrition-III software. This study was approved by the Medical Ethics Committee of Tabriz University of Medical Sciences, Tabriz, Iran and all subjects were given adequate information, and the consent was obtained from each volunteer. The study was carried out in Tabriz University of Medical Sciences, between 30 October 1998 and 19 December 1998 .

Sampling. Blood samples (8 ml) were obtained after 12 hours fasting at 18 o'clock on the last day of each dietary program and the plasma was separated and stored at -20^{0}C until use. Total cholesterol, triglyceride, lipoprotein (a) and glucose levels were determined by enzymatic methods. The concentrations of LDL-C and HDL-C were assessed by enzymatic-based precipitation technique. The level of insulin was measured by radioimmunoassay method.

Statistical analysis. All values have been expressed as mean ± SD. The results obtained from 2 diets were compared with each other using Student's paired t-test. The difference was considered significant at level of $p<0.05$.

Results.

All subjects showed a good adherence to the study and were able to complete the protocol and the timing of the meals and dietary tables were well-followed by the subjects. In **Table 1**, the detailed composition of both diets followed by subjects has been tabulated. No significant difference was found between 2 diets in terms of food composition and calorie intake indicating that 2 diets followed by subjects can be considered identical apart from meal frequency. The influence of the nibbling and gorging diets on plasma levels of lipids, glucose and insulin obtained in the present study has been summarized in **Table 2.** No significant differences were found between 2 diets with respect to total cholesterol, LDL-C, HDL-C and triglyceride levels. However, lipoprotein (a) level was found significantly lower on nibbling as compared with gorging. The nibbling diet was also associated with a significant lower level of insulin and a significant higher level of glucose (**Table 2**).

Discussion.

The effect of meal frequency on glucose metabolism and lipid profiles is not new and returns to more than 50 years ago. An increased meal frequency is usually associated with decreased levels of blood insulin and glucose, although in some other studies, these changes have not been found significant. According to some studies concerning the effects of feeding frequency on lipid profiles, total cholesterol and LDL-C concentrations are reduced following the nibbling diet compared with the gorging diet.[2,6-8] Therefore, it has been suggested that the nibbling diet has a beneficial effect on cardiovascular diseases.[6,7,11] However, no significant differences in total cholesterol and LDL-C levels were found in the present study. No significant difference in total cholesterol and LDL-C concentrations have also been reported by others and the beneficial effect of nibbling diet on cardiovascular diseases has been taken under question by some authors.[13,15,17] Murphy et al[13] using a randomized open cross over study on gorging and nibbling diets have demonstrated no significant differences in fasting total cholesterol and LDL-C concentrations, which is consistent with our finding. However, unlike other

Table 1 - Characteristics of energy and macronutrient intakes in the nibbling and gorging diets.*

Energy and macronutrients	Nibbling	Gorging	*p* value†
Energy (kcal/day)	2387.3 ± 206.2	2290.8 ± 201.3	0.169
Energy as fat %	26.9 ± 5.2	24.5 ± 1.7	0.122
Energy as protein %	11.2 ± 1.3	11.4 ± 1.5	0.381
Energy as carbohydrate %	61.8 ± 5.1	64.4 ± 2.4	0.115
Fats (g)	74.4 ± 16.3	62.2 ± 7.4	0.155
Protein (g)	68.5 ± 11.1	64.4 ± 15.3	0.283
Carbohydrate (g)	381.8 ± 43.5	368.6 ± 40.7	0.263
Sugar (g)	53.1 ± 9.7	46.1 ± 18.2	0.070
Fiber (g)	22.3 ± 3.5	21.3 ± 4.5	0.289

*All data expressed as mean ± SD (N=15), †The comparison between both groups was made using Student's paired t-test

Table 2 - Plasma levels of glucose, insulin and lipids measured at the end of the nibbling and gorging diets.*

Energy and macronutrients	Nibbling	Gorging	*p* value†
Cholesterol (mg/dl)	186.1 ± 25.2	192.7 ± 24.8	0.166
LDL-C (mg/dl)	118.8 ± 18.1	123.9 ± 20.2	0.167
HDL-C (mg/dl)	46.1 ± 4.4	45.2 ± 4.6	0.236
Triglyceride (mg/dl)	112.7 ± 59.9	114.4 ± 64.0	0.357
Lipoprotein (a) (mg/dl)	36.4 ± 4.5	38.3 ± 5.2	0.015
Glucose (mg/dl)	85.1 ± 6.3	81.2 ± 6.4	0.008
Insulin (μIU/ml)	4.1 ± 3.3	7.7 ± 5.8	0.035

*All values expressed as mean ± SD (N=15), †The comparison between both groups was made using student's paired t-test, LDL-C - low-density lipoprotein-cholesterol, HDL-C - low-density lipoprotein-cholesterol

studies,[6,7,16] they have found a significant increase in HDL-C levels following gorging diet compared with nibbling diet.[13] No significant difference in HDL-C level observed in our study has been also mentioned by some others.[6,7,18] The high level of insulin is consistent with the low level of glucose. A significant high level of insulin during gorging diet in comparison with a nibbling diet has been also reported by Jenkins et al;[6,7] however, in their study, this high concentration of insulin during gorging diet was also associated with a non-significant high level of glucose. It could be possible that the maximum rate of glucose absorption in the gorging diet continues for a longer time and the higher level of glucose induces the secretion of insulin, which results in the augmentation of tissue level of glucose; so the blood level of glucose decreases while the insulin level remains still at a high level. On the other hand, during nibbling diet, nutrients are presented at a reduced rate and almost frequently but low level of glucose absorption leads to low secretion of insulin. Therefore, it is likely that in the nibbling diet, body is adapted for a reduced secretion of insulin accordingly and a relatively high level of glucose.

In conclusion, based on the results obtained in this study, it is difficult to recommend an increase in the meal frequency as a dietary intervention to improve lipid profile and reduce some risk factors for cardiovascular diseases. There is also no evidence of long-term benefit of increased meal frequency in people with non-insulin-dependent diabetes, as well as in hyperlipidemic individuals.[17] Furthermore, difficulties in following an increased meal frequency throughout the day particularly during busy work periods make impossible to extrapolate these results to daily life and it is difficult to recommend a well-defined and controlled nibbling diet for the public at large.[7,12] Even, in those studies that a positive change in lipid profiles in terms of cardiovascular risk factors has been demonstrated, the authors have not advocated the use of the model of increased meal frequency.[6] In addition, it is more likely that, in practice, increased numbers of meals will lead to increased food consumption and weight gain[19] and moving to the nibbling pattern of eating is considered as a major factor in the etiology of obesity.[20] All these studies also suffer from limited period of experimental dietary regimens, deficiency in quantifying periodicity of eating, the absence of a standard and comprehensive research method, variation in the meaning of meal or snack between different cultures and individuals.[1,7,12,13] Therefore, although there would be no advantages in recommending the nibbling dietary pattern for normal subjects, its metabolic benefits in obese people under a well-defined and controlled diet is subject for further studies.

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