INFLUENCE OF FOOD ON DAILY PROFILES OF STEROIDS

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Introduction

A large amount of information has been accumulated on the time structure of the endocrine system. Circadian rhythms of physiological actions including metabolism and behaviour are generated by central and peripheral circadian oscillators, which are tuned up by environmental or physiological stimuli. A master circadian pacemaker in the hypothalamic suprachiasmatic nucleus (SCN) is directly controlled by daily changes of light/dark cycles, and coordinates the timing of other oscillations by direct and indirect neuronal, hormonal and behavioral signals. The daily rhythm of food intake creates a circadian signal that is transmitted to the peripheral and central oscillators. Some of these could be involved in the daily rhythm of food anticipatory activity (Herbin and Bléthazar 2015). The highly coordinated output of the hypothalamic biological clock not only governs the daily rhythm in sleep/wake or feeding/feeding behaviour but also has direct control over many aspects of hormone release. In fact, a significant proportion of our current understanding of the circadian clock has its roots in studies of the intricate connections between the hypothalamic clock and multiple endocrine axes (Katsev and Franks 2012).

Methods

Eight women (mean age 29.4±2.99 years, mean BMI 21.3±1.3kg/m²) in follicular phase of menstrual cycle were examined. The levels of C-peptide, glucose, LH, FSH, SHBG, oestradiol A, ghrelin, cortisol, testosteron, dihydrotestosteron, progesteron, pregnenolone, estriol and estradiol were studied during a daily regimen (16 hours) that included standardised food intake. The first blood withdrawal was at 6 a.m. (30 minutes after awakening) after overnight fasting. The next withdrawals were always one and two hours after eating according to the following schedule (7:15, 8:15, 10:15, 11:15 a.m.; 1:15, 2:15, 4:15, 5:15, 7:15, 8:15 p.m.). The last blood withdrawal was 30 minutes before sleep, at 9:30 p.m. Breakfast (2 slice of bread, ham, cheese and tea) was served at 6:15, a snack (yogurt) at 9:15, lunch (beef broth soup, turkey, potato dumplings, and sauerkraut) at 12:15, an afternoon snack (apple) at 15:15, and dinner (tomato, 2 slices of bread, ham and cheese) at 18:15.

Results

The majority of the hormones showed significant differences of their levels during the day between hours and especially between subjects (Table 1). Non-significant differences between hours were only found for oestradiol, testosteron, and dihydrotestosteron (Table 1, H-F), and non-significant differences between subjects (Table 1, S-F) were only found for oestradiol, glucose and C-peptide.

A significant increase of glucose and C-peptide was observed 1 and 2 hours following the main meals lunch and dinner (P = 0.011. Fig. 1 A,B; means and 95% confidence intervals are given in all figures). The most striking marker of food intake was the increase of C-peptide (Fig. 1B), which was significant after breakfast, lunch and dinner.

Ghrelin levels had a significant minimum after lunch and dinner (Fig. 1C), whereas the differences in oestradiol levels over the course of the day were insignificant (Fig. 1D, Table 1). LH and FSH (Fig. 2A B) showed a continuous decrease during the day, with no significant additional decrease after main meals. Androgen levels (testosterone Fig. 3A, dihydrotestosteron Fig. 3B) did not show significant relationships to food intake, with the exception of an increase in dihydrotestosteron 2 hours after lunch. Dihydroprogesteron (Fig. 3C) significantly decreased 1 and 2 hours after lunch and breakfast respectively SHBG (Fig. 3C) showed a small decrease after main meals.

All three C21 steroids (cortisol Fig. 4A, progesterone Fig. 4B and pregnenolone Fig. 4C) showed a significant decrease one hour after awakening, then a continuous decrease during the day. Cortisolem decreased continuously throughout the day, and an additional significant decrease of cortisol related to food intake was only observed 2 hours after lunch (Fig. 4A).

Conclusions

In our study the known nychthemeral rhythm of LH, FSH, cortisol, dehydroepiandrosterone, progesterone and pregnenolone and decrease of ghrelin after food intake were confirmed, but significant changes after meals were also newly observed for the levels of cortisol, dehydroepiandrosterone, estradiol and SHBG. These effects were seen only after the main meals lunch and dinner. After breakfast, these effects are probably masked by the huge changes in the nychthemeral rhythm, and after snacks (yogurt and apples) the effects of food intake were either too small or the time period between eating the meal and the blood withdrawal was too long. It follows that for analytical determination of above mentioned hormones not only the time of blood withdrawals but also food consumption has an important influence upon the resulting values.

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