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COLD MILK ACCELERATES ORO-CECAL TRANSIT TIME DURING THE LUTEAL PHASE BUT NOT THE FOLLICULAR PHASE IN WOMEN

MIEKO KAGAYA[1], NAYUMI IWATA[1], YASUSHI TODA,[2] TAKAHIRO MITSUI[3], YASUYUKI NAKAE[3] and TAKAHARU KONDO[3]

[1] *Department of Food and Nutrition, Sugiyama Jogakuen University School of Life Studies, Hoshigaoka Motomachi, Chikusa-ku, Nagoya*
[2] *Kinjyo Gakuin University, Nagoya*
[3] *Research Center of Health, Physical Fitness and Sports, Nagoya University, Furo-cho, Chikusa-ku, Nagoya*

ABSTRACT

The effect of the menstrual cycle on oro-cecal transit time (OCTT) has been controversial. Since poor reproducibility of OCTT measurements by lactulose might be responsible for this controversy, we measured OCTT with either milk or a solid test meal during the luteal and follicular phases of the menstrual cycle. Nine healthy young women (21.9 ± 0.42 years old) with regular menstruation were studied for 4 consecutive menstrual cycles. Control (37°C) or cold (10°C) milk was used as a liquid meal, and the OCTT measurements were taken 3 times at each milk temperature during each of the 2 phases for 3 consecutive menstrual cycles. OCTT after a solid test meal (cooked rice, miso soup, a boiled egg, and cooked soybeans with mixed vegetables) was studied twice in 1 menstrual cycle. Breath hydrogen was determined every 15 min for 6 h. OCTT was defined as the time when breath hydrogen showed a sustained rise of 3 ppm or more from baseline. OCTT was not different between the luteal and follicular phases when the test meal was control milk or the solid meal. When cold milk was used as the test meal, OCTT was significantly shorter during the luteal phase (134 ±15 min) than during the follicular phase (165 ± 21 min). In conclusion, cold milk accelerates OCTT during the luteal phase but not the follicular phase of the menstrual cycle in women.

Key Words: Cold milk, Menstrual cycle, Oro-cecal transit time (OCTT)

INTRODUCTION

Wald et al.[1] reported that oro-cecal transit time (OCTT) was significantly prolonged during the luteal phase of the menstrual cycle compared with the follicular phase. They measured OCTT using 11.5 g of lactulose in 100 ml of water, but the reproducibility of the lactulose method for the measurement of OCTT has been questioned.[2-5] In fact, Turnbull et al.[6] reported that the menstrual cycle had no effect on OCTT measured with lactulose in a mixed nutrient soup meal, which has been known to give better reproducibility.[3,7]

Usually the temperature of the liquid test meal is not standardized in these experiments, and is assumed to be about 37°C. A lower temperature will influence gastric emptying,[8] which may in turn cause OCTT to change. In this report, we tried to clarify the combined effect of menstrual cycle phase and temperature of the test meal on OCTT using three different test meals:

Correspondence: Takaharu Kondo, M.D., Ph.D., Research Center of Health, Physical Fitness and Sports, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan (fax: +81-52-789-3957, e-mail: kondo@htc.nagoya-u.ac.jp)

control (37°C) and cold (10°C) milk and a solid meal. Milk and the solid test meal have been shown to give better reproducibility in OCTT than a lactulose test meal.[2,7,9)]

MATERIALS AND METHODS

Subjects

The subjects studied were 9 female students majoring in nutrition. They were between 21 and 26 years of age (age 21.9 ± 0.4 years, weight 52.1 ± 0.68 kg, and BMI 20.0 ± 4.1; mean ± SEM). The regularity of their menstrual cycles was confirmed by serum estradiol and progesterone measurements during the study. None of the subjects had symptoms suggesting gastrointestinal disease or a previous illness affecting gastrointestinal transit. All subjects gave written informed consent for their participation in the study.

Protocol

The subjects were instructed to avoid foods containing nonabsorbable carbohydrates or dairy products on the day before the study. After an overnight fast, each subject consumed one of the 3 test meals in a randomized order: 1) the solid meal consisted of 200 g cooked rice, 50 ml miso (made from fermented soy bean curd) soup, a boiled egg, and 95.5 g cooked soybeans with mixed vegetables (565 kcal, 17.0 g protein, 14.1 g fat, 92.9 g carbohydrate, and 7 g dietary fiber); 2) the control milk meal was 300 ml of milk at 37°C (192 kcal, 9.9 g protein, 9.6 g fat, and 13.5 g carbohydrate); and 3) the cold milk meal was 300 ml of milk at 10°C. These test meals have been proven to provide satisfactory levels of breath hydrogen for assessment of OCTT and to be reasonably reproducible.[2,9)]

The solid test meal was given on 2 occasions, one in the follicular phase of the menstrual cycle (days 8–10 with day 1 being the 1st day of menstrual bleeding) when progesterone levels were low and the other in the luteal phase (days 18–20) when progesterone levels were increased. The experiments with either control or cold milk were repeated 3 times at each temperature, 2 times in each menstrual cycle, so that the subjects were studied for 3 consecutive cycles. Blood was drawn twice during one menstrual cycle, and serum samples were stored at –40°C for later analysis for progesterone and estradiol, which were measured by radioimmunoassay.[10)]

Using commercially available collection bags,[2,9)] end alveolar breath samples were collected during the fasting state and at 15-min intervals for 6 h after the test meal. Breath hydrogen concentration was measured by gas chromatography (Microlizer 12i, Quintron Instruments, Milwaukee, Wis., USA). OCTT was defined as the time when 3 consecutive hydrogen readings in the breath exceeded basal value by 3 ppm or more, and the rise was sustained thereafter.[2,7,9)] The area under the hydrogen concentration-time curve (AUC) was calculated from the triangular area under the curve for 6 h after the test meal.[9)]

Statistical analysis

Values are expressed as mean ± SEM. In the milk experiments, either control or cold, a mean of 3 measurements during the follicular or luteal phases was used for statistics. A two-tailed paired t test was used for statistical analysis. $P < 0.05$ was considered significant.

RESULTS

All subjects had normal menstrual cycles. Progesterone and estradiol levels increased during the luteal phase ($p < 0.01$, Table 1).

OCTT measured after cold milk intake during the luteal phase was 134 ± 15 min, which was shorter than that measured during the follicular phase (165 ± 21 min, $p < 0.05$, Fig. 1). OCTT measured after control milk or the solid meal did not differ between the follicular phase and the luteal phase (Fig. 1).

Table 1. Serum hormone levels

	Follicular phase	Luteal phase
Progesterone (ng/ml)	0.58 ± 0.05	9.43 ± 2.28**
Estradiol (pg/ml)	34.7 ± 5.6	99.2 ± 21.3**

** $p < 0.01$ compared with the follicular phase

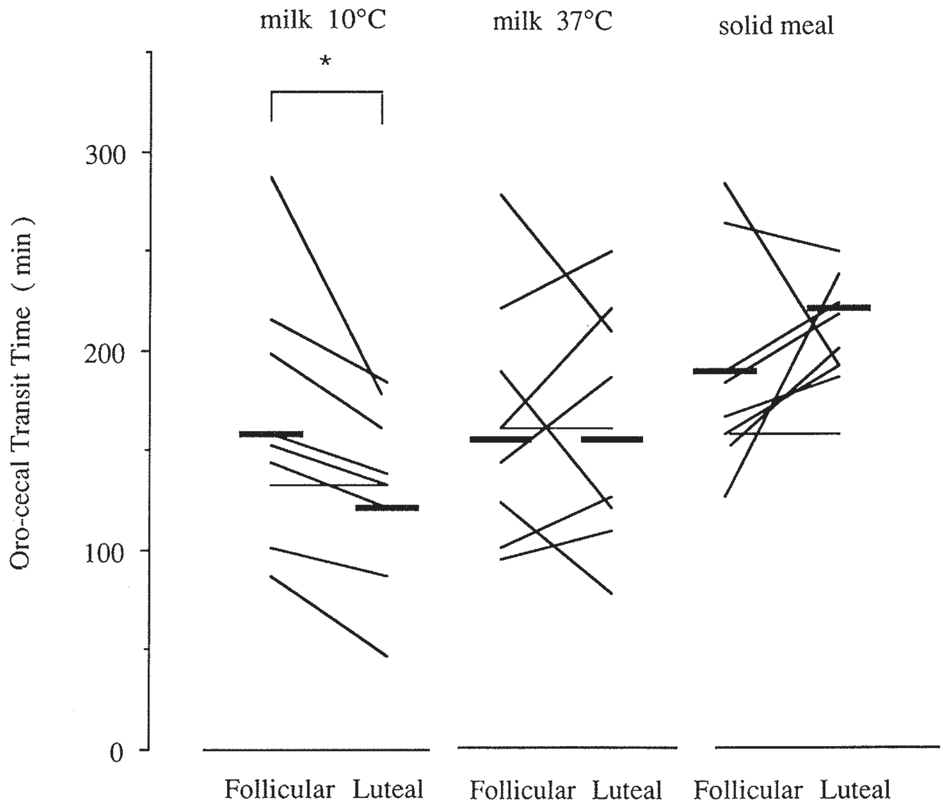

Fig. 1. Oro-cecal transit time
Means of 3 measurements are shown in the milk experiments. Horizontal bars indicate mean values.
* $p < 0.05$

Table 2. Area under the curve (ppm × min)

	Follicular phase	Luteal phase
Milk 10°C	13137 ± 2613	14074 ± 2431
Milk37°C	11633 ± 1855	10690 ± 1629
Solid meal	10271 ± 1313	10256 ± 1888

OCTT measured after cold milk was compared with that measured after control milk irrespective of the menstrual cycle phase. When both phases were combined, there were no significant differences between OCTTs measured with cold (150 ± 17 min) or control milk (161 ± 18 min).

Total breath hydrogen excretion (AUC) did not differ significantly between menstrual cycle phases with any of the test meals used (Table 2).

DISCUSSION

In the present study, OCTT measured with cold milk (10°C) was significantly faster during the luteal phase of the menstrual cycle than during the follicular phase. The phase of the menstrual cycle had no effect on OCTT measured with either control (37°C) milk or a solid test meal at an ordinary temperature. Cold milk itself had no effect on OCTT if the menstrual cycle phases were ignored. From these results, we concluded that the accelerating effect of cold milk on OCTT is somehow related to the luteal phase. One of the factors which has been known to influence OCTT during the luteal phase is progesterone.[1] Progesterone, however, has been postulated as a factor that causes gastric atony[11,12] or small bowel hypomotility[1,13,14] during pregnancy or during the luteal phase of the menstrual cycle. OCTT during pregnancy or the luteal phase reportedly is prolonged when lactulose is used as the test meal.[1,13,14] However, when milk or a solid meal in this report, or lactulose with nutrients in another report[6] was used as the test meal, OCTT did not change during the luteal phase. The effect of progesterone on gastrointestinal motility seems to appear only after non-nutrient ingestion, and that effect is a slowing of the OCTT. In this respect, the accelerating effect of cold milk during the luteal phase could not be due to progesterone.

Excessive prostaglandin production within the uterus has been reported to cause painful menses or dysmenorrhea.[15] Prostaglandins have been known to stimulate intestinal motility.[16] Uterine prostaglandins are usually rapidly metabolized, but if excessive amount of prostaglandins were produced, entered the circulation and were delivered to the gastrointestinal smooth muscle, intestinal motility could be stimulated.[17] The effect of prostaglandins on the OCTT, however, is controvercial in experimental animals.[18-19] In humans, OCTT measured with a barium meal introduced intragastrically was shortened by oral administration of PGE_2.[20] PGE1 given orally at a dose that increased intestinal motility induces diarrhea.[21] The physiological effect of intrinsic prostaglandins, which vary during the menstrual cycle, on the OCTT has not been determined yet.

OCTT includes not only small bowel transit time but also gastric emptying. The menstrual cycle has been reported to delay[11,12] or have no effect on gastric emptying of solid meals[22-24] and to have no effect on gastric emptying of a liquid meal[6,24] or the liquid-phase of a solid meal.[12] Since the acceleration of OCTT during the luteal phase was observed only after the liquid cold milk, it may not be related to gastric emptying.

Sun et al. reported that cold drinks delay gastric emptying via mucosal thermoreceptors, which are optimally sensitive at 10–12°C, but only 10 min after ingestion.[8] Others[25] have reported that cold drinks have no effect on gastric emptying, but they measured gastric emptying with an aspiration technique, and gastric emptying was first measured 15 min after ingesting the meal. A lower temperature seems to slow gastric emptying at an earlier phase after meal ingestion. Our observed accelerated OCTT during the luteal phase could not be due to slowed gastric emptying, if any, caused by the cold milk.

It is a common belief in Japan that drinking too much cold liquid will result in diarrhea. Pregnant women therefore are told not to drink cold liquids. Although why cold milk accelerates OCTT remains unclear, drinking it may be effective for constipation during the luteal phase or during pregnancy.

In conclusion, cold milk but not control milk or a solid meal, accelerated OCTT during the luteal phase of the menstrual cycle. This effect of cold milk is not conclusively due to increased progesterone levels or altered gastric emptying, if any.

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