

# Bowel function and transit rate during the menstrual cycle

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**SUMMARY** The whole gut transit rate has been measured in the follicular and luteal phases of the menstrual cycle in 18 healthy women in whom ovulation was confirmed biochemically. Mean transit time in the follicular phase (45.2 (2.7) h, mean (SEM) was not significantly different from the luteal phase (51.3 (4.1)),  $p=0.12$ . Stool weight was also not significantly different in the two phases (132 (7) v 123 (10) g/day). A diary card kept for the entire menstrual cycle revealed no change in bowel frequency or stool consistency during the menstrual, follicular or luteal phases. Under normal physiological conditions the sex hormones do not have a major effect on bowel function.

The female sex hormones are thought to affect gastrointestinal function. Some women describe changes in bowel habit at different times during their menstrual cycle, although these changes are variable for different women.<sup>1</sup> During pregnancy there is an increased incidence of heartburn and constipation.<sup>2</sup> Changes in lower oesophageal sphincter function, gastric emptying, and gall bladder function have also been noted during pregnancy.<sup>3,5</sup>

Several studies have examined the relationship between gastrointestinal transit and sex hormones.<sup>6-9</sup> Orocaecal transit times have been measured in women during the follicular and luteal phases of the menstrual cycle. One study demonstrated prolonged transit in the latter,<sup>6</sup> but a similar study using a different test meal demonstrated no change.<sup>7</sup> Orocaecal transit measured during the third trimester of pregnancy was slower than when remeasured in the postpartum.<sup>8</sup>

These studies have measured upper gastrointestinal transit only, yet the greatest proportion of intestinal transit time is spent in the colon. It is therefore likely that if sex hormones affect gastrointestinal smooth muscle, and hence transit, that this should be reflected in changes in the whole gut transit time and bowel habit during the menstrual cycle.

## Methods

### SUBJECTS

Twenty healthy women (mean age 32 years; range

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22-47) without history of gastrointestinal complaints and regular menstruation participated in the study. No subject was taking the oral contraceptive or any other medication. Bowel frequency ranged from 0.5-3.0/day. Subjects were asked to maintain their usual diet and fibre intake, without variation, throughout the study period. All days in the menstrual cycle were counted from the first day of menstrual bleeding (day 1). All subjects gave informed consent and the study was approved by the City and Hackney Health Authority Ethical Committee in December 1986.

### DETERMINATION OF INTESTINAL TRANSIT TIME

Subjects were randomly allocated to begin the study in the first half (11 subjects) or second half (nine subjects) of the menstrual cycle. Each subject swallowed three different sets of radiologically distinguishable radio-opaque polyvinyl chloride shapes (Portex Ltd, UK) at 8 am on three successive days. These shapes are of a similar specific gravity to faeces and have been validated previously as an accurate means of assessing transit.<sup>10</sup> The shapes were swallowed on days 5, 6, and 7 of the menstrual cycle and stools collected from day 5, to assess transit in the follicular phase. Shapes were swallowed on days 19, 20, and 21 and stools collected from day 19 to determine the luteal transit rate.

Stools were collected in a plastic bag which was positioned on the toilet seat. Specimens were then immediately labelled with the subject's code number, and the date and time of the bowel action. Specimens were transported in a sealable plastic container, and stored at  $-20^{\circ}\text{C}$  until they were radiographed. Stools were collected for seven days or longer until all the

shapes had been observed on a radiograph. The stools were radiographed using Kodak Ortho-G film (rare earth screens) at an exposure of 45kV, 0.03 sec and 100 mA.

The transit rate in each half-cycle was accurately determined using the technique described by Cummings *et al.*<sup>10</sup> The mean transit rate for each set of 20 shapes was determined according to the formula:

$$\text{Mean transit time (h)} = \frac{\sum_{i=1}^n x_i t_i}{\sum_{i=1}^n x_i}$$

where  $x_i$  is the number of radio-opaque pellets present in the stool passed after time interval  $t_i$ . The three successive days transit rates were averaged to minimise the effect of day-to-day variation. Transit was calculated for a particular day's ingested shapes only if 19 or 20 of the shapes were identified on x-ray.

#### DETERMINATION OF OVULATION

Venous blood samples were taken on the morning of day 5 for determination of oestradiol and progesterone concentrations during the follicular phase of the menstrual cycle. Further samples were taken on days 19, 21, and 23 to be certain of documenting a luteal progesterone concentration diagnostic of ovulation. Blood samples were allowed to stand till clotted, then centrifuged and the serum stored at  $-20^{\circ}\text{C}$ .

Oestradiol concentrations were determined by direct radioimmunoassay using a 125-I-radiolabelled tracer and a PEG-assisted second antibody separation system (DPC, Wallingford, UK). The detection limit for this assay is 20 pM/l. Three quality controls were included in each assay at 100, 500, and 1000 pM/l, with an interassay coefficient of variation of 8, 6, and 8% respectively.

Progesterone concentrations were determined using a 125-I-radiolabelled tracer and 20% PEG separation system.<sup>11</sup> The detection limit for this assay is 4 nM/l. Three quality controls were included in each assay at 10, 35, and 65 nM/l, with an interassay coefficient of variation of 10, 6, and 8% respectively.

#### BOWEL HABIT AND STOOL WEIGHT

Subjects kept a record of the date and time of all bowel motions from day 1 of the cycle until the beginning of the next menstrual cycle. Bowel frequency was then expressed as number of stools per five day period (menstrual, follicular, and luteal) to eliminate the effects of day to day variation. Separate note was taken of the bowel frequency and consistency on the first day of menstruation and a record was also kept for the entire cycle as to whether each stool was watery, loose, soft, firm or hard.

All stools were weighed during the follicular and luteal stool collections.

#### STATISTICAL ANALYSIS

Results are expressed as mean values (SEM). A paired *t* test was used to compare transit rates, bowel frequencies and stool weights in different phases of the cycle. Chi-squared analysis was used to compare the stool consistency in the different phases of the cycle. Regression analysis was undertaken using the least squares method.

#### Results

##### SEX HORMONE DETERMINATIONS

Eighteen women ovulated as evidenced by a peak luteal progesterone concentration of greater than or equal to 19 nM/l.<sup>12</sup> In addition, all 18 subjects menstruated after their luteal observation phase at the expected time. These 18 subjects form the basis of all the results presented. The values obtained for peak serum oestradiol and progesterone in the follicular and luteal phases for these 18 subjects are shown in Table 1. Of these 18 subjects, nine began the study in the follicular phase and nine in the luteal phase of the menstrual cycle.

##### TRANSIT RATE

Of a total of 2160 PVC shapes administered, 2136 were identified on x-ray (99%). In all subjects, either 19 or 20 shapes were identified in at least two of the three single shape studies in each half cycle.

The mean whole gut transit rate was not significantly different for the follicular and luteal phases (Table 2). The mean difference in paired transit times

Table 1 *Hormone concentrations during the menstrual cycle*

	Oestradiol pM/l	Progesterone nM/l
Follicular – mean (SEM)	168 (24)	5.1 (0.7)
– range	40–460	4–11
Luteal – mean (SEM)	620 (62)	53.3 (5.4)
– range	145–1200	19–120

Range and mean concentrations in the 18 subjects who ovulated. Expressed as mean (SEM).

Table 2 *Transit rate, bowel frequency and stool weight during the menstrual cycle*

	Menstruation	Follicular	Luteal	<i>p</i> Value
Transit rate (h)		45.2 (2.7)	51.3 (4.1)	0.12
Bowel frequency				
– per 5 days	5.1 (0.6)	5.6 (0.5)	5.2 (0.4)	0.37
– first day menstruation	1.1 (0.2)			
Stool weight (g/day)		132 (7)	123 (10)	0.37

Expressed as mean (SEM).

Table 3 Stool consistency and the menstrual cycle

	Stools (n)	Total stools (%)				
		Hard	Firm	Soft	Loose	Watery
Menstruation	52	4	38.5	44	13.5	0
Follicular	51	4	27.5	66.5	2	0
Luteal	52	2	27	63	6	2

Results of the diary kept for the entire cycle by 16 subjects. The total number of stools is calculated over three days during each part of the cycle (days 1-3, 5-7, and 19-21). There is no significant difference in stool consistency between the three phases ( $p=0.19$ ,  $\chi^2$  analysis).

between the follicular and luteal phases was 6.1 hours (95% confidence interval -1.9 to +14.1 hours). Twelve subjects showed a longer transit time in the luteal phase compared to the follicular phase, while in six subjects the luteal transit time was shorter.

#### BOWEL HABIT

Sixteen subjects kept an accurate diary during the study. There were no significant differences between the bowel frequencies during menstruation and the follicular and luteal phases (Table 2). Considering the first day of menstruation separately, the mean bowel frequency did not differ from the rest of the menstrual phase or the follicular and luteal phases. Only one subject noted an increased bowel frequency on the first day of menstruation. There was a slight tendency toward looser stools during menstruation, but this was not significantly different from the follicular or luteal phase (Table 3). There was no difference in stool consistency between the follicular and luteal phases (Table 3). The stool weight did not differ significantly for the follicular and luteal phases (Table 2).

#### RELATIONSHIP OF HORMONE CONCENTRATIONS TO TRANSIT RATE

There was a positive correlation between the transit rate and the peak serum oestradiol ( $r=0.61$ ,  $p=0.007$ ) and between the transit rate and peak serum progesterone ( $r=0.59$ ,  $p=0.01$ ) in the follicular phase of the cycle. There was no correlation for oestradiol ( $r=0.21$ ,  $p=0.40$ ) or progesterone ( $r=0.07$ ,  $p=0.78$ ) in the luteal phase.

There was no correlation between the change in transit rate between the follicular and luteal phases and the change in either the serum oestradiol ( $r=0.12$ ,  $p=0.64$ ) or serum progesterone ( $r=0.05$ ,  $p=0.84$ ).

#### RELATIONSHIP BETWEEN TRANSIT TIME AND STOOL WEIGHT

There was a significant negative correlation between transit time and stool weight in both the follicular

( $r=0.68$ ,  $p=0.002$ ) and luteal ( $r=-0.58$ ,  $p=0.011$ ) phases. Thus subjects with the fastest transit tended to have the heaviest stools.

#### Discussion

This study has shown no significant difference between the follicular and luteal intestinal transit rates. Twelve of the 18 subjects showed a longer luteal than follicular transit time while six subjects showed the reverse. These results are at variance with the study by Davies *et al* in which women in the luteal phase were found to have a longer whole gut transit time than other women who were in the follicular phase, postmenopausal or taking the oral contraceptive pill.<sup>9</sup> However, the subjects were not matched, the numbers studied were small, and no paired studies were performed in the same subjects. Our finding of a negative correlation between transit time and stool weight is in agreement with their work,<sup>9</sup> and has been shown to relate partly to variation in fibre intake.<sup>9</sup>

Wald *et al* have reported prolongation of the oro-caecal transit time during the luteal phase in a group of 15 menstruating women.<sup>6</sup> The biochemical parameters confirming ovulation were not defined, however. In addition, the transit time was determined by ingestion of lactulose in water during the fasting state. The use of lactulose in water alone may not accurately reflect the true 'fed' small bowel transit rate, as the stimulus is insufficient to eliminate the fasting small bowel pattern of phase three activity.<sup>12</sup> We have carried out a similar study using a meal of soup containing lactulose, and did not show a difference in oro-caecal transit between the follicular and luteal phases.<sup>7</sup>

Slowed transit during the third trimester of pregnancy, compared with postpartum, has also been described.<sup>8</sup> Serum oestradiol and progesterone concentrations, however, are substantially higher during late pregnancy than during the luteal phase. Changes in other hormones which influence gastrointestinal function may also contribute to an altered transit rate. For example, the serum concentration of motilin, a known gastrointestinal motor stimulant, is reduced during pregnancy.<sup>13</sup>

The positive correlation between transit rate and oestradiol and progesterone concentrations during the follicular phase suggests that at lower concentrations these hormones may affect gut function. The lack of correlation during the luteal phase may be the result of receptor saturation, or other hormonal factors exerting a greater influence. Experimentally, the sex hormones can be shown to influence transit. Male rats treated chronically with oestradiol and progesterone show slower intestinal transit than

controls.<sup>14</sup> In another study in rats in which only colonic transit was measured, ovariectomy hastened transit.<sup>15</sup> Furthermore, the administration of oestradiol and progesterone, but especially the latter, had an inhibitory effect on transit.<sup>15</sup> *In vitro* studies on canine<sup>16</sup> and rat<sup>17</sup> colonic tissue have shown an inhibitory effect of progesterone on muscle contractility. Receptors for oestrogen and progesterone have been demonstrated in colonic mucosa,<sup>18</sup> but their presence in colonic muscle has not been determined.

Despite this experimental evidence that the female sex hormones influence gastrointestinal smooth muscle function, we have not confirmed a change in gastrointestinal transit or bowel habit during the menstrual cycle, under normal physiological conditions. Either the magnitude of the hormone changes is insufficient to influence motor activity or the effect is so small that it is not clinically significant.

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