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The normal range and a simple diagram for recording whole gut transit time

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Abstract. The time taken for radio-opaque markers to pass through the intestine has been measured in 25 healthy men, and 18 healthy women in both the follicular and luteal phases of the menstrual cycle. The subjects collected all stools after ingestion of the markers, the number of markers present in each stool was counted on a radiograph, and the number of markers retained in the body was thus determined for 12 hourly intervals after ingestion. The mean values (2 standard deviations) for men and women in both phases of the menstrual cycle proved to be so similar that the results have been combined to provide a single normal range. These data for the normal range for retained markers (as assessed by plain radiograph) are presented in diagrammatic form for clinical use. To assess whether a patient's whole gut transit time lies within the normal range a single type of marker can be used and an abdominal radiograph performed at 12 or 120 hours, the limits of the normal range. Normal subjects retain more than 20% of markers within 12 hours and less than 80% after 120 hours. If desired more information can be gained by giving different types of marker on successive days, so that several transit studies providing intermediate values can be obtained from a single abdominal radiograph at 120 hours.

Résumé. Le temps mis par des marqueurs radio-opaques pour parcourir l'intestin a été mesuré chez 25 hommes sains et 18 femmes saines, à la fois dans les phases folliculiniques et lutéiniques du cycle menstruel. Les sujets collectaient toutes leurs selles après ingestion de marqueurs. Le nombre de marqueurs présents dans chaque selle était compté par radiographie, et le nombre de marqueurs retenus dans le corps était ainsi déterminé lors de douze intervalles horaires après ingestion. Les valeurs normales ($\pm$ 2 déviations standards) pour les hommes et les femmes dans les deux phases du cycle menstruel se sont révélées être tellement similaires que les résultats ont été combinés pour fournir, une valeur normale unique. La valeur normale des marqueurs retenus (affirmée sur la radiographie) est présentée sur un diagramme pour un usage clinique. Pour évaluer si le temps de transit intestinal d'un patient se tient dans des valeurs normales un simple type de marqueur peut être utilisé et une radiographie abdominale effectuée à 12 ou 120 h, les limites de valeurs normales. Les sujets normaux conservent plus de 20% des marqueurs en 12 h et moins de 80% après 120 h. Pour plus d'information on peut utiliser différents types de marqueurs à des jours successifs, ainsi plusieurs temps de transit fournissant des valeurs intermédiaires peuvent être obtenus d'une simple radiographie abdominale à 120 h.

Introduction

As part of the evaluation of patients with intestinal motor disorders it is helpful to determine their whole gut transit time.

In a previous study we determined the normal whole gut transit time in 25 healthy males [1]. Radio-opaque markers were ingested and all stools collected and x-rayed until all the markers had been passed. A similar method was used in a subsequent study [2] to determine the normal whole gut transit time in both the follicular and luteal phases of the menstrual cycle in a group of healthy women. We have used the data from both of these previous studies to derive the number of shapes remaining in the bowel at 12 hourly intervals for each subject. The normal range for each group has then been determined ($\pm$2 SD). This information can be used to determine whether a patient's transit time falls within the normal range by taking a single abdominal radiograph after the ingestion of radio-opaque markers. The aim of the study was to establish a normal range for intestinal transit time, so that patients can be assessed with a single radiograph and their result plotted on a graph of the normal range for comparison.

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Methods

Subjects

Twenty-five male (mean age 31 years, range 17–44) and twenty female (mean age 32 years, range 22–47) healthy volunteers without gastrointestinal symptoms were studied. Subjects were asked to maintain their usual diet, throughout the study period. The women experienced regular menstruation; no subject was taking the oral contraceptive or any other medication. Bowel frequency ranged from 0.5–3.0/day. All days in the menstrual cycle were counted from the first day of menstruation (day 1). All subjects gave informed consent.

Determination of intestinal transit time

Male subjects ingested 20 radio-opaque markers on one occasion, following which their stools were collected and x-rayed until all the markers were recovered. The radio-opaque markers used were of a similar specific gravity to faeces and have been validated against Chromium Oxide as an accurate means of assessing transit [1].

Female subjects were randomly allocated to begin the study in the first half (11 subjects) or second half (9 subjects) of the menstrual cycle. Each subject swallowed 3 different sets of radiologically distinguishable radio-opaque markers at 8 a.m. on 3 successive days. The markers 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. Markers 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 under 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 °C until they were x-rayed. Stools were collected for 7 days or longer until all the shapes had been observed on a radiograph. The stools were x-rayed using Kodak Ortho-G film (rare earth screens) at an exposure of 45 kV, 0.03 sec and 100 mA.

For each male subject the number of markers which had not been excreted was determined for 12 hourly intervals following ingestion, until all markers had been excreted. For the females the number of markers retained was calculated separately for each of the three markers. Hence for the females three separate transit studies were obtained for all 20 subjects in the follicular phase and a further three luteal phase studies for each of the 18 subjects who ovulated (determined by measurement of serum progesterone). For each female the three separate studies in each phase of the menstrual cycle were averaged. For males and females the mean and range (mean ± 2 SD) of the number of markers remaining in the intestine at 12 hourly intervals were then calculated.

Results

Progesterone determinations

Eighteen women ovulated as evidence by a peak luteal progesterone concentration of greater than or equal to 19 nM/L [3]. In addition, all 18 subjects menstruated after their luteal observation phase at the expected time. These 18 subjects form the basis of the luteal results presented. Of these 18 subjects, 9 began the study in the follicular phase and 9 in the luteal phase of the menstrual cycle.

Transit time

Out of a total of 2540 markers administered to the male subjects, 2521 were recovered (99%).

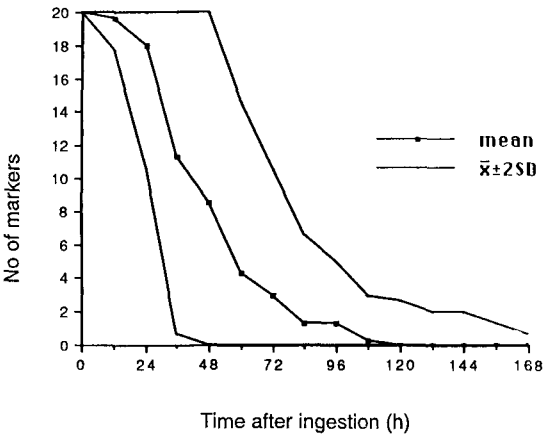


Fig. 1. The normal range (mean ± 2 SD) for the number of retained radio-opaque markers at various times after the ingestion of 20 markers. This is derived from the composite data for men, and women in both phases of the menstrual cycle

Table 1. Normal range in men and women for the number of retained radio-opaque markers on x-ray after the ingestion of 20 markers at time 0. Range calculated as Mean ± 2 SD

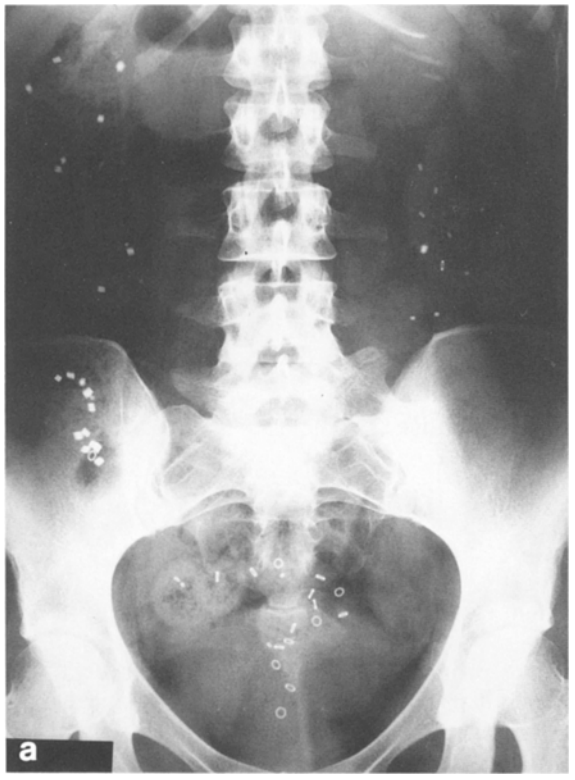
Time after ingestion of Markers (hours)	Female				Male	
	Follicular		Luteal			
	Mean	Range	Mean	Range	Mean	Range
0	20	–	20	–	20	–
12	20	19–20	20	18–20	19	16–20
24	18	11–20	18	10–20	18	11–20
36	12	0–20	12	2–20	10	0–20
48	10	0–20	9	0–20	7	0–20
60	4	0–11	5	0–16	4	0–17
72	2	0– 7	4	0–15	3	0–10
84	1	0– 5	2	0– 8	2	0– 7
96	1	0– 2	2	0– 7	1	0– 6
108	–	0– 2	–	0– 2	1	0– 5
120	–	0– 2	–	0– 2	–	0– 4
132	–	0– 1	–	0– 1	–	0– 4
144	–	0– 1	–	0– 1	–	0– 4
156	–	0– 1	–	0– 1	–	0– 2
168	–	0– 1	–	0– 1	–	0

Out of a total of 2160 PVC markers administered to the female subjects, 2136 were identified on stool x-rays (99%). In all women, either 19 or 20 markers were identified in at least two of the single marker studies in each half cycle; if the third collection contained less than 19 markers, the data for that marker were not included.

The mean and range (2 SD) for the number of markers remaining in the abdomen at different times after the ingestion of 20 markers is shown in Table 1.

Since the three groups of data are so similar a composite graph for all the male and female measurements obtained is shown in Fig. 1. Each female contributed only one value derived from the mean of the follicular and luteal transit data. This single definition of the normal range appears adequate for clinical purposes.

An example of how this normal range can be used to assess a patients transit time, using three markers and a single radiograph, is shown in Fig. 2.



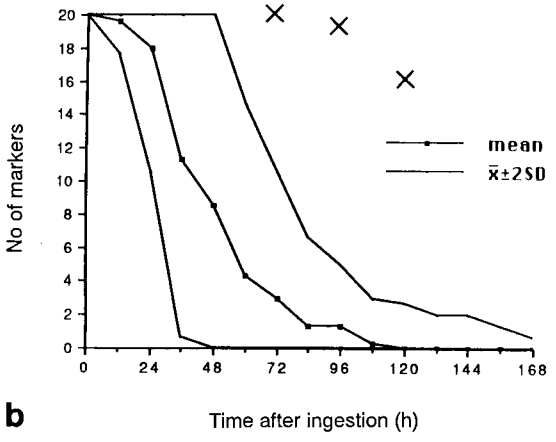


Fig. 2. **a** This x-ray of a patient complaining of constipation was taken 120 hours after the ingestion of 20 ring markers, 96 hours after the ingestion of 20 small cylinder markers and 72 hours after the ingestion of 20 large cube markers. There are 16 rings, 19 cylinders and 20 cubes remaining. **b** When these values are plotted on the normal range graph, it can be seen that all three of the transit studies fall outside the normal range, indicating consistently delayed intestinal transit

Discussion

For clinical purposes, a simple test of intestinal transit time is needed which gives a rapid answer with minimal irradiation. About half of normal people pass 50% of markers at 36–48 hours but the normal range at that time extends from 0–100%. For this reason, discrimination between normal and abnormal is greatest at the extremes when normally fewer than 20% or more than 80% of markers have been passed.

Different shaped markers can be used to give a measure of transit at 72, 96 and 120 hours after ingestion from a single abdominal radiograph; these results can be plotted on the diagram for normal subjects so that an assessment of normality or otherwise of the patient's transit rate can be seen at a glance. The use of three markers taken on consecutive days reduces the effect of day to day variation in transit time, by providing three transit studies from one radiograph.

Our finding that 95% of normal subjects pass fewer than 20% of markers within 12 hours and more than 80% of markers within 120 hours, is similar to our original observation in male subjects [1]. We found little difference in the transit times between males and females, similar to previous studies [6] and therefore felt it was reasonable to combine the data from the two groups of subjects. Any difference between the sexes is likely to be of little clinical significance.

The intestinal transit studies should be interpreted in light of the time the patient has defaecated. A patient who has a grossly decreased bowel frequency, but who defaecates just prior to the abdominal radiograph, may clear most of the radio-opaque markers and thereby appear to have a normal transit time. The times of defaecation should therefore be recorded. In a patient with decreased bowel frequency but a normal transit study, this problem can be overcome by the use of more frequent radiographs or the use of radioisotopes [7].

In summary, we believe the data provided should enable physicians to perform simple studies of intestinal transit, taking radiographs at a time convenient to the physician and patient.

References

1. Hinton JM, Lennard-Jones JE, Young AC (1969) A new method for studying gut transit times using radio-opaque markers. Gut 10:842–847
2. Kamm MA, Farthing MJG, Lennard-Jones JE (1989) Bowel habit and whole gut transit time during the menstrual cycle. Gut 30:605–608
3. Wathen NC, Perry L, Lilford RJ, Chard T (1984) Interpretation of single progesterone measurements in diagnosis of anovulation and defective luteal phase: observations on analysis of the normal range. Br M J 288:7–9
4. Cummings JH, Jenkins DJA, Wiggins HS (1976) Measurement of the mean transit time of dietary residue through the human gut. Gut 17:210–218
5. Davies GJ, Crowder M, Reid B, Dickerson JWT (1986) Bowel function measurements of individuals with different eating patterns. Gut 27:164–169
6. Metcalf AM, Phillips SF, Zinmeister AR, MacCarty RL, Beart RW, Wolff BG (1987) Simplified assessment of segmental colonic transit. Gastroenterology 92:40–47
7. van der Sijp JRM, Kamm MA, Nightingale JMD, Walker E, Granowska M, Morris GP, Lennard-Jones JE, Akkermans LMA (1991) Assessment of regional colonic transit in severe idiopathic constipation: superiority of radioisotope compared to radioopaque markers. Gut 32:A575

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