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A SCINTIGRAPHIC STUDY OF MASS PERISTALSIS IN HUMAN COLON

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Summary: Although many attempts have been made to study human colonic motility, the colonic transit is still poorly understood. Both spontaneous and neostigmine-induced peristalsis of the colon were studied with scintigraphy. A polythene tube was inserted into the cecum through a colonofiberscope. 37 MBq of ^{99m}Tc-DTPA and 75ml of saline were instilled and dynamic scan was begun. Eight healthy volunteers were examined by the method above mentioned. The sampling time was set at fifteen seconds in six persons and three seconds in the rest. 0.5mg of neostigmine was injected intravenously to stimulate the paristalsis when no peristalsis occurred within thirty minutes after the study was begun. Dynamic scanning was performed for sixty to ninety minutes. This scintigraphic study revealed that the spontaneous and induced peristalsis were almost identical on colonogram. ^{99m}Tc-DTPA solution was propelled from the cecum and ascending colon to the sigmoid colon or the rectum for about fifteen seconds during mass peristalsis. Colonogram (time-activity curve) enables us to analyze mass peristalsis easily and more objectively than colonoscintigram. The spontaneous and neostigmine-induced peristalsis seemed to be almost identical in all but one of eight subjects.

Index Terms

mass peristalsis, scintigraphy, colonofiberscopy

INTRODUCTION

The motility of the large bowel is poorly understood. Cannon[1] first reported the original radiological observations on animals in 1902. Holzknecht described "mass peristalsis" as a wave of contraction that moved down a narrowed section of the colon from which the interhaustral folds has temporarily disappeared[2]. Since then, various studies of mass peristalsis have proved difficult because it occurs infrequently. Induced peristalsis such as stripping wave which is stimulated by an enema and normal peristalsis can be regarded as identical[3].

In the present study. both spontaneous and induced peristalsis of the colon were studied by means of scintigraphy. The main purpose of this study is to record mass peristalsis, which occurs infrequently. Three spontaneous instances of mass peristalsis and five of neostigmine -induced peristalsis were recored in this study.

MATERIALS AND METHODS

Eight healthy volunteers were examined as to their large bowel movements. They were six

Table Detailes of subjects

No.	Age (years)	Sex	Bowel movement (/day or days)
1	69	Female	1/2
2	51	Male	1/1
3	29	Male	1/1
4	50	Female	1/1
5	52	Male	2/1
6	48	Male	1-2/1
7	45	Male	2/1
8	71	Male	1-2/1

males and two females and the mean age was 51.9 years with a range of 29-71 years. They showed no abdominal symptoms or significant findings in barium enama and total colonofiberscopy. Their bowl habits ranged from twice a day to once in two days.

After a careful explanation about the aims of the study, each subject gave us informed consent, and the investigations were conducted according to the recommendations of the Helsinki Declaration.

As the first step, a guide wire was inserted into the cecum through a colonofigerscope and a polythene tube was inserted using the guide wire. Bowel preparation was done by the modified Brown's mothod[9]. Colonic irrigation was not performed because it was thought to stimulate colonic peristalsis. Air was inflated as little as possible when the colonofigerscope was inserted into the cecum. During colonoscope withdrawal, air was aspirated as completely as possible. Five or 10mg of diazepam was injected intravenously when necessary. Thirty misutes after total colonofiberscopy, the location of the polythene tube was cofirmed by fluoroscopy. 37 MBq of milking technetium 99 diethylene triamine pentaacetic acid (^{99m}Tc-DTPA) and 75ml of saline (37℃) was infused through the polythene tube for about thirty seconds. The tube was pulled out carefully after injection of ^{99m}Tc-DTPA solution.

As the second step, dynamic scanning was begun using the scintilation camera PHO GAMMA LFOV (Searle Radiographics Inc.) and data analysis was done by nuclear medicine computer system Scintipac 1200 (Shimazu Corporation). The sampling time was set at fifteen seconds in six subjects and, for more precise study, three seconds in the other two subjects. If no peristalsis occurred within thirty misutes after the study was begun, 0.5mg of neostigmine was injected intravenously to stimulate peristalsis. The dynamic scanning was performed for sixty to ninety minutes. The serial frames of each colonoscintigram were observed and analysis of time-activity curve (colonogram) was perfored. For the purpose of computer analysis, five anatomical regions of the colon and rectum were defined using a composite picture derived from all the frames. Then the five regions of interest (ROIs) were determined. The five regions were A : cecum and ascending colon, T : transverse colon, D : descending colon, S : sigmoid and R : rectum. Time-activity curve was calculated in each ROI.

For the statistical analysis, the data were statistically analysed by using Student's t test. The rejection level was 5% in the analysis of the results.

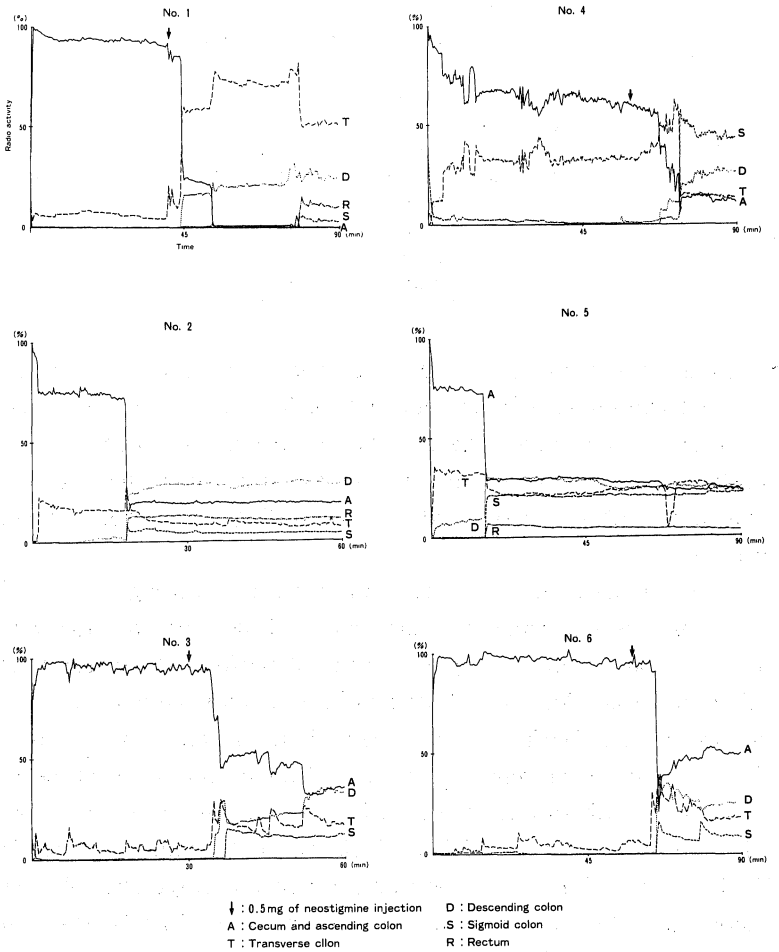

Fig. 1. Colonogram (time-activity curve) in the first six subjects. The radioactivity of each part of the large bowel suddenly changed and then became constant. While the radioactivity of the cecum and ascending colon (A) was decreased, that of the descending colon (D) and the sigmoid colon (S) was increased in five subjects. The radio activity of the rectum (R) was increased in three of five subjects. In another subject (No.4), the colonograms changed gradually.

RESULTS

The colonograms of the six subjects are shown in Figure 1. In five subjects, the radioactivity of each part of the large bowel suddenly changed and then became constant. While radioactivity of the cecum and ascending colon was decreased, that of the descending colon and sigmoid colon was increased in five subjects. In another subject (No. 4), the colonograms chaned gradually, Spontaneous mass peristalsis and neostigmine-induced peristalsis seemed to be almost identical on colonogram. However, spontaneus peristalsis was thought to be more rapid and more clear than neostigmine-induced peristalsis between the during onset and the end

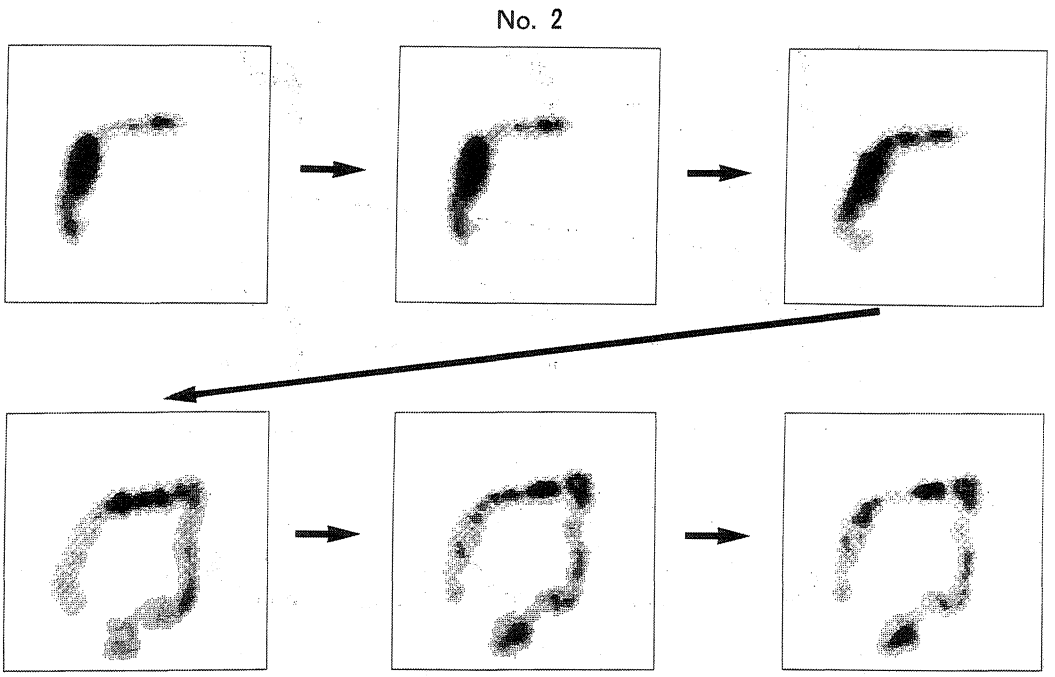

Fig. 2. The serial frames of colonoscintigram in subject (No.2). Rapid movement of ^{99m}Tc-DTPA nolution was thought to occur between third and fouth frames of colonoscintigram. Sampling time was settled fifteen seconds in this subject.

of peristalsis.

The leading portion of ^{99m}Tc-DTPA solution progressed rapidly during the peristaltic state. Figure 2 shows the serial frames of colonoscintigram in a subject (No. 2). The mass peristalsis was thought to have occurred for about fifteen seconds. In the last two subjects, sampling time was set at three seconds. A more precise analysis was performed. Figure 3 shows the serial frames of colonoscintigram in these two subjects. In both subjects, the mass of the ^{99m}Tc-DTPA solution was propelled smoothly from the cecum and ascending colon to the sigmoid colon and rectum.

Figure 4 shows the colonograms of the last two subejcts in the peristaltic state. Induced peristalsis is shown in one subject (No. 7) and spontaneous peristalsis in the other subject (No. 8). These two colonograms were thought to be identical. The peak of radioactivity in the transverse and the descending colon appeared in turn in a short delay soon after sudden decrease of radioactivity in the cerum and ascending colon. ^{99m}Tc-DTPA solution was finally pooled from the sigmoid colon and rectum. The time durations for mass peristalsis were thought to be fifteen and eighteen seconds, respectively. The analysis of colonogram revealed that the cecum and ascending colon were the starting points of mass peristalsis, and the sigmoid colon and rectum were the terminal points. ^{99m}Tc-DTPA solution only passed through the transverse colon and descending colon during mass peristalsis.

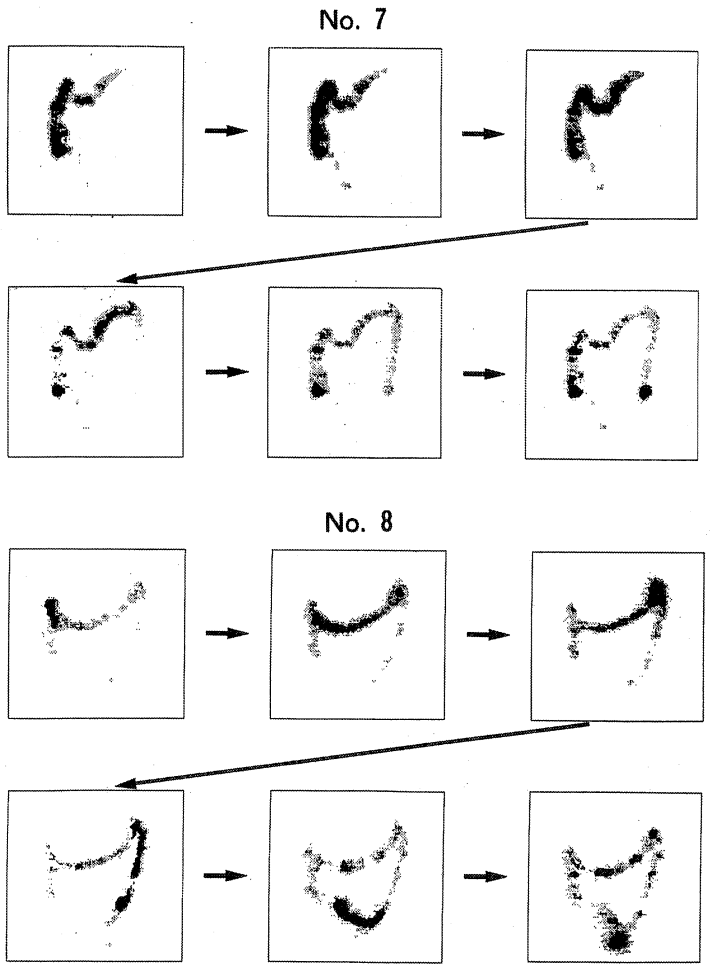

Fig. 3. The serial frames of colonoscintigram in subjects (No.7, 8). The dynamic scanning was performed every three seconds. ^{99m}Tc-DTPA solution was passed through the transverse colon and the descending colon.

DISCUSSION

The transit of colon has been studied by various methods[10,11]. B. Krevsky and associates reported the colonic trasit scintigraphy using the 50μ Ci of indium 111-diethylene triamine pentaacetic acid (^{111}In-DTPA). ^{111}In-DTPA was instilled through a polyvinyl tube in the cecum by oral intubation technique[12]. Idiopathic costipation was observed and analyzed by this method[13]. In Japan, K. Murakami (one of the present authours) studied the cololic transit using 1 mCi of ^{99m}Tc-DTPA. ^{99m}Tc-DTPA was instilled through a polythene tube in the cecum by intubation technique with colonofiberscopy[14,15]. Polythene tube was located in the cecum exactly by this technique in a short time. This scintigraphic study of colonic motility was thought to be the ideal method because of low radiation exposure, noninvasive imaging, subject

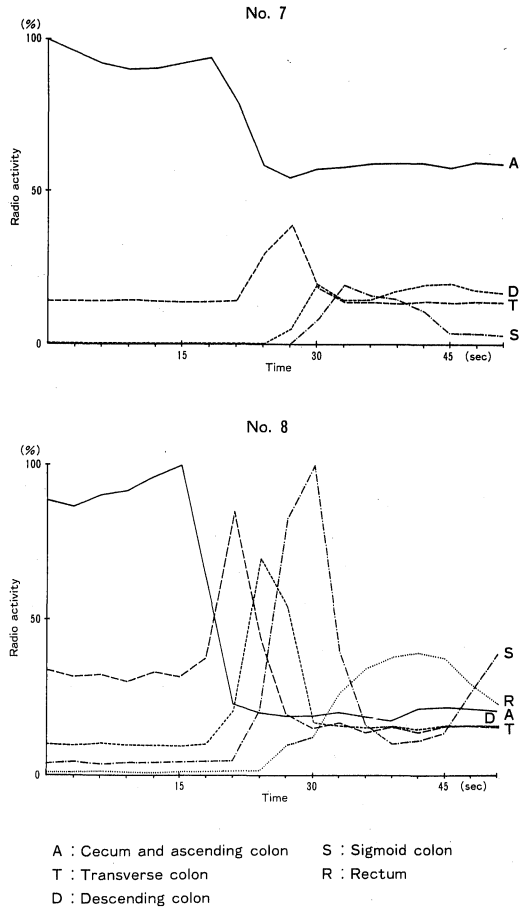

Fig. 4. Colonograms of the subjects (No. 7, 8). Induced peristalsis by 0.5mg of neostigmine injection was shown in subject No.7 and spontaneous mass peristalsis was shown in subject No.8. The peak of radio activity in the transverse and descending colon appeared by turn with short delay in aborad direction soon after sudden decrease of the radioactivity in the cecum and ascending colon. ^{99m}Tc-DTPA solution was pooled in the sigmoid colon and the rectum finally.

comfort, and facility for quantitave analysis[12].

Mass peristalsis was studied by fluoroscopy, radiotelemetering of intraluminal pressures, and intraluminal baloons[3-8]. Mass peristalsis defines a vigorous propulsive activity that dislocates colon contents peristaltically over a long tract of the large bowel in an oro-aboral direction[8]. Investigation of spontaneous colon peristalsis has proved difficult because it occurs infrequently[5]. J. Ritchie reported its occurrence in his fluoroscopic study in only three out of 73 observations over an avarage period of 40 minutes[7]. G. Bassotti and his associates reported that 6.1 mass movements per twenty-four hours were recognized in their eighteen healthy

volunteers[8]. Induced peristalsis such as stripping wave which is stimulated by an enema and normal peristalsis can be regarded as identical[3]. M. A. Kamm et al observed the peristalsis induced by bisacodyl in idiopathic constipation patients by means of dynamic scanning. They reported no spontaneous movement of isotope over a 10-15 minute observation period until bisacodyl was introduced into the right colon in their six controls. Then, there was a uniformly rapid respense in all their six controls[16]. In our series. three of eight subjects were exhibited spontaneous mass peristalsis. Spontaneous and neostigmine-induced peristalsis were thought to be almost identical in eight subject except one (No. 4). Though diazepam was jnjected intravenously, the occurrence of mass peristalsis was very high. One of the reasons why mass peristalsis was observed so frequently in our series may be the influence of colonofiberscopy upon colonic motility by contact stimulation. G. Bassotti et al adopted almost the same method of this intubation techsique using colonofigerscope and diazepam for thier manometric study, and reported their results of 6.1 mass movemonts per twenty four hours[8]. Another reason may be the volume effect of saline (75ml). 75ml of saline was instilled for thirty seconds. Phillips and Giller repoted the typical peak velume which normally might enter the cecum in one minute was 8 ml[17]. B. Krevsky and his associates advocated that the "Mass movements" similar to those described by Cannon[1] were observed during the stuby period in some subjects. They observed that the front of radioisotope activity traversed the distance from the cecum to the sigmoid colon in less thas one minute[12]. Our results suggest that the duration of mass peristalsis was about fifteen seconds, and the time-activity curve exhibited more clearly the movement of ^{99m}Tc-DTPA solution in each part of the bowel in three seconds scanning. This scintigraphic study revealed the movement of the liqluied content of the prepared bowel. So these results may not be always physiological because the large bowel content is solid under normal conditions. However, this method should provide some new knowledge on colonic transit.

In conclusion, the scintigraphy revealed the mass perisoalsis precisely.

1. Scintigraphic study revealed the movement of bowel contents continuously and quantitatively.

2. ^{99m}Tc-DTPA solution propelled from cecum to sigmoid colon or rectum for about fifteen seconds during mass perisalsis.

3. Analysis of colonogram (time-activity curve) during mass peristalsis was easier and more objective than colonoscintigram.

4. Spontaneous and induced peristalsis by neostigmine were thought to be almost identical in all subjects except one.

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