Radiologic Studies of Rectal Evacuation in Adults with Idiopathic Constipation

G. K. TURNBULL, M.D., F.R.C.P.(C),* C. I. BARTRAM, F.F.R., F.R.C.P., J. E. LENNARD-JONES, M.D., F.R.C.P.

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A consecutive series of 58 patients with idiopathic constipation and 20 control subjects were studied by evacuation proctography and measurements were made of changes during rectal expulsion. A wide range was found in the control group. The anorectal angle, pelvic floor descent, and the presence or size of an anterior rectocele did not discriminate between the control and patient groups. Internal intussusception was rare. Among constipated patients, the only significant differences from normal were in the time taken to expel barium and the amount of barium remaining in the distal rectum. The majority of control subjects (15 of 20) evacuated most of the barium within 20 seconds whereas 45 of 58 constipated patients took a longer time. Using the area of barium on a lateral view of the rectum as a measure, 19 of 20 control subjects evacuated at least 60 percent of the barium from the distal 4 cm of the rectum compared with only 25 of 58 patients. A varying degree of defecatory impairment was thus established among many patients with constipation. The patients were subdivided into those with a normal or abnormal whole gut transit rate as an indication of colonic function, and those who did or did not need to digitally evacuate the rectum as a clinical manifestation of an anorectal disorder. No obvious differences were found between these subgroups using the parameters measured. [Key words: Proctography; Constipation; Defecography]

From St. Mark's Hospital, London, United Kingdom

CONSTIPATION, DEFINED AS INFREQUENT and/or difficult evacuation,[1] may be a troublesome, and even disabling, symptom.[2] Although dietary fiber deficiency is a common cause, increased intake makes some patients feel worse.[2,3] These patients may have a rectal expulsion disorder, as shown by their inability to pass a water-filled balloon used to simulate a soft fecal bolus.[3-8] Radiologic studies of defecation, using the dynamic technique of evacuation proctography, have also demonstrated that these patients have difficulty in evacuating barium either as a liquid suspension[9] or as a semisolid paste.[3,10]

Electromyographic studies of the external sphincter[3,5,7-10] and measurements of the anal pressure in adults[5] and children[11,12] have shown a parodoxical contraction of the striated muscles of the pelvic floor during defecation straining in patients with constipation. Integrated radiologic, electromyographic, and intrarectal manometric studies have shown contraction of the pelvic floor with a rise in intrarectal pressure associated with retention of barium in some constipated patients.[10]

Evacuation proctography[13,14] is a relatively simple and rapid examination, acceptable to patients. From the video recording it is possible to quantify rectal evacuation, both in volume and time, as well as the more routine measurements of the position of the pelvic floor and anorectal angle. In constipation, the whole-gut transit may be normal or abnormal, and some patients need to digitally evacuate the rectum. The possibility that impaired rectal

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Address reprint requests to Prof. Lennard-Jones: St. Mark's Hospital, City Road, London EC1V 2PS, England.

*G. K. Turnbull was a McLaughlin fellow, Dalhousie University, Halifax. Present address: Halifax Infirmary, 1335 Queen St., Halifax, Nova Scotia, Canada B3J 2H6.

evacuation, as shown on proctography, may be related to transit rate has been explored and proctography used to determine if there is a mechanical abnormality, such as an internal intussusception, that explains the need for some patients to aid evacuation digitally.[13,15,16]

Materials and Methods

Subjects

Control Subjects: Ethical approval for these studies was obtained from the City and Hackney District Ethical Committee in January 1985, and each subject gave informed written consent to the examination. Control subjects were limited to men who did not expect to father any more children and to women beyond the age of child-bearing. All except one control subject had been referred for barium enema for a reason other than a defecatory disorder. Thirteen were referred for routine follow-up some years after removal of an adenomatous polyp. Of those with symptoms, two had rectal bleeding (1 no cause found, 1 cancer of the descending colon), one had a change in bowel habit, and three had right iliac fossa pain. No patient with a history of a defecatory disorder or an anorectal abnormality on examination was included.

Selection of Patients: A consecutive series of 58 patients who complained of constipation was studied. Each patient fulfilled a widely accepted definition of this symptom,[1] that is, a history of passing fewer than three bowel actions weekly or of straining more than 25 percent of the time. Patients were included only if there was no related previous surgical treatment, no cause for the constipation found from a detailed history or physical examination including sigmoidoscopy, or hematologic and biochemical tests, no evidence of megarectum on sigmoidoscopy or barium enema, and a normal rectoanal inhibitory reflex present on balloon distention of the rectum.

The patients were divided into three groups. Those who gave no history of digital evacuation of the rectum were divided into those with a normal and those with a prolonged whole-gut transit rate (see below). The need to digitally evacuate the rectum was taken as clinical evidence of a severe defecatory disorder and details of the patients who gave this history were analyzed separately.

Methods

Whole-Gut Transit Time: Patients were instructed to take a high fiber diet and all laxatives, suppositories, and enemas were stopped on the day before 20 radiopaque markers were taken by mouth with breakfast. Five days later an abdominal radiograph was taken, the total number of markers remaining in the colon was counted and, when ten or more were present, their distribution was mapped.[17] A period of five days was chosen because a previous study had shown that control subjects pass at least 16 of the markers within this time.[18] To analyze segmental transit using one type of marker, more frequent x-rays are needed. These were not performed so as to reduce the radiation dose of the pelvis to a minimum among young patients and because many patients were unable to visit the hospital daily.

Evacuation Proctography: With the patient lying in the left lateral position, 120 ml of a thick barium paste ("Microtrast®," Nicholas Laboratories, Slough, England) which weighs 200 g and has a viscosity of 500 to 800 poise at 20° C was injected into the rectum using a bladder syringe and short flexible catheter. Injection was continued as the catheter was withdrawn through the anal canal to mark it with a trail of barium. The patient was then seated sideways in the screening unit on a specially constructed commode with a radiolucent perspex seat and 4 mm copper side plate to attenuate screen glare[14] below the patient.

The video recording was started with the patient at rest and during expulsion of the barium, which the patient was encouraged to do as quickly and completely as possible. The recording was continued until the patient had emptied as much of the rectum as possible or had been straining adequately for about 60 seconds, and had relaxed, allowing the pelvic floor to return to its resting position. Radiation measurements showed a gonadal dose of 0.036 to 0.053 cGy, which was much less than for a barium enema measured in the same way.

Measurement of Pelvic Floor Descent: The level of the anorectal junction was measured in relation to the plane of the ischial tuberosities, and was either above (positive) or below (negative). The anorectal junction was defined as the narrowest point where the distal rectum tapers into the anal canal.

Anorectal Angle: The anorectal angle was measured between a line drawn through the central axis of the anus and a line drawn along the posterior wall of the distal rectum. This is in accordance with many previous papers,[4,8,13] though in some the middle of the rectal lumen was used.[7,15,19,20]

Width of the Anal Canal: The width of the anal canal at maximum opening was measured and adjusted for magnification by reference to a 1-cm lead marker placed in the center part of the seat (average magnification, 1.4:1).

Time for Rectal Evacuation: The evacuation time was taken from the moment of first passage of barium through the anal canal until evacuation was complete, or for a maximum of about 60 seconds.

Proportion of Distal Rectum Evacuated: The outline of the barium in the rectum at the beginning and end of evacuation was traced on paper and the silhouette arbi-

trarily divided into segments, each 4 cm in length measured along the axis of the rectum and perpendicular to the rectal wall. The area of each segment was determined by cutting out and weighing the paper segments. Values were expressed as a percentage increase (barium can distend the lower rectum during failure of expulsion) or decrease over the resting value. With the quantity of barium used, it was possible to measure the two distal segments in this way but proximal segments were incompletely filled.

Measurement of Rectocele: Rectocele formation was defined as any ballooning of the anterior or posterior rectal wall beyond the expected line and was measured from the extrapolated expected line to the most distal point of the rectal wall.

Statistical Analysis: Comparisons between groups were made by the *t*-test for two independent variables,[21] paired *t*-test, or Fisher's exact test where appropriate, $P < .05$ was considered significant.

Results

Details of the Control Subjects and Patient Groups: Clinical details of the control subjects and constipated patients are shown in Table 1. The control subjects were somewhat older than the constipated patients, for ethical reasons, and there was a higher proportion of men because the constipated patients were predominantly women. The occurrence of abdominal symptoms in the control subjects is in keeping with the frequency reported in the general population.[2,22]

There was little difference in the symptoms commonly associated with constipation comparing the three groups of constipated patients (Table 1). Of the patients reporting they had to strain to pass stool, 17 of the 20 with normal whole-gut transit rate, 14 of the 16 with slow transit, and all patients who practiced manual evacuation said that they strained at stool daily, often without success. The median times (and ranges) spent in straining at stool reported by the patients were: 15 (3 to 30) min/day for patients with normal transit, 30 (5 to 90) min/day for patients with slow transit, and 30 (5 to 120) min/day for those who used digital evacuation. The other patients who reported straining at stool did so at least twice a week when they had the urge to defecate.

Radiopaque Markers: Results of the transit studies in the constipated patients are shown in Fig. 1. The 31 patients in whom four or fewer markers were present on the abdominal radiograph at five days were regarded as having a normal transit rate and the 25 other patients as showing delayed transit. Two male patients who practiced regular digitation of the rectum did not complete the colonic transit study.

Distribution of the markers in those with ten or more remaining markers showed that, in most patients, markers were distributed in the left colon, the rectosigmoid, and the rectum.

Qualitative Observations: During evacuation in the control subjects the anal canal was open widely. Evacuation of the "zone of evacuation"[14] in the distal rectum was rapid, in a median of 14 seconds, and complete. A small anterior rectocele was common in female patients, but without barium trapping at the end of evacuation.

By contrast, the constipated subjects emptied slowly and incompletely. An anterior rectocele in some female patients was more pronounced than in the controls and, at the end of the evacuation, barium was trapped within the closed loculus of the rectocele in 33 of 58 patients as compared with only one of 20 controls (Table 2).

All proctograms were analyzed carefully for internal intussusception, which is defined as an infolding of the rectal wall with abnormal movement of the fold toward the anal canal. Internal intussusceptions may be intrarectal or intra-anal. Two patients from the digital evacuation group showed intra-anal intussusceptions.

Descent of the Pelvic Floor: The level of the pelvic floor at rest and during evacuation of the barium is shown in Fig. 2. There were no significant differences between the control subjects and any group of constipated patients (Table 2).

Anorectal Angle: The anorectal angle at rest and dur-

TABLE 1. *Patient Details*

	Controls (20)	Normal Transit (24)	Slow Transit (20)	Manual Evacuators (14)
Sex: M:F	10:10	1:23	0:20	5:9
Age*	58 (34-70)	27 (19-54)	31 (19-44)	47 (28-75)
Interval between BO (in days)*	1 (0.5-1)	5 (1-28)1†	8 (1-28)4†	2 (0.2-14)1†
Duration (in years)*	-	7 (1-50)	14 (1-42)	20 (2-60)
Incomplete emptying	ND	21	17	13
Defecation straining	0	20	16	10
Abdominal pain	5	18	18	9

*Median (range).
†No. unable to pass stool without laxatives.
ND: no data.

ing evacuation of barium is shown in Fig. 3. Among the control subjects, the angle widened during evacuation in all but one. The angle became more acute in 10 of 44 constipated patients who did not use digital evacuation (not significant) but this decrease did not correlate with the proportion of barium emptied from the rectum. There were no significant differences in the angles at rest or on evacuation between the groups (Table 2).

Width of Anal Canal: There were no significant differences in the maximum width of the anal canal during evacuation between the control or any of the patient groups (Table 2), although there was a tendency for the canal to be narrower with delay in transit and digital evacuation.

Time for Rectal Evacuation: The time was prolonged in constipated patients (Fig. 4) compared with the control subjects ($P < .01$) but no difference was observed between the constipated groups (Table 2).

Proportion of the Distal Rectum Emptied: The constipated patients evacuated significantly less barium from the distal rectum (Fig. 5) than the control subjects ($P < .01$) and this difference was greatest in the distal 4 cm of the rectum (Table 2). In a few constipated patients the area of barium in this distal segment actually increased due to filling of a large anterior rectocele from above. The constipated patients with normal transit evacuated more barium ($P < .05$) from the distal 4 cm of the rectum than those with slow transit but did not differ significantly

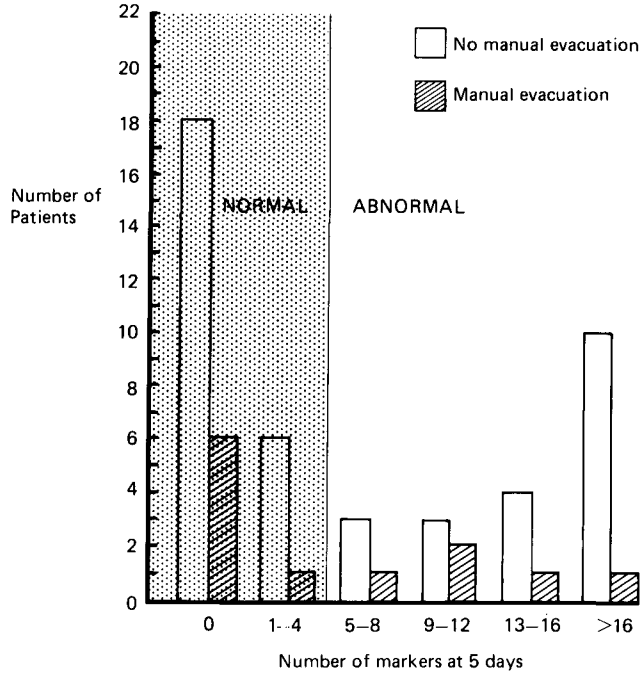

FIG. 1. The number of radiopaque markers counted on a radiograph of the abdomen five days after each patient had taken 20 markers by mouth. In normal subjects, no more than four markers are still present at five days (two subjects did not complete the test).

TABLE 2. *Results Summary Table*

	No.	Perineal Descent (cm) Rest	Evac	Recovery	ARA (degrees) Rest	Evac	Evac Time (sec)	Area Change on evac (%) 4 cm	4 to 8 cm	Anal Canal Width	Rectocele with Barium Trapping
Controls	20	+0.8 ± 2.46	−2.0 ± 1.9	+0.6 ± 2.5	94 ± 19	113 ± 16	14 ± 10	−85 ± 13	−82 ± 15	1.4 ± 0.3	1/20
Normal Transit	24	+1.0 ± 1.46	−3.2 ± 1.24	−0.1 ± 1.85	99 ± 21	120 ± 16	29‡ ± 16	−64† ± 33	−67* ± 25	1.3 ± 1.1	10/24‖
Slow Transit	20	+1.0 ± 1.4	−2.8 ± 1.5	−0.03 ± 2.4	98.4 ± 26.5	113 ± 33.4	32† ± 17	−39†§** ± 28	−65* ± 29	1.1 ± 0.5	14/20¶
Manual evacuation	14	−0.6 ± 2.1	−3.0 ± 1.6	−1.4 ± 2.7	94 ± 24	124 ± 25	38† ± 23	−40††† ± 39	−55† ± 29	1.0 ± 0.5	9/14‖

Results expressed as mean ± SD.
*"Two sample" *t*-test, $P < .05$ *vs.* control.
†"Two sample" *t*-test, $P < .01$ *vs.* control.
‡"Two sample" *t*-test, $P < .001$ *vs.* control.
§"Two sample" *t*-test, $P < .05$ *vs.* normal transit.
‖Fisher's exact test, $P < .05$ *vs.* control.
¶Fisher's exact test, $P < .0005$ *vs.* control.
**Paired *t*-test, $P < .001$ *vs.* 4 to 8 cm segment.
††Paired *t*-test, $P < .05$ *vs.* 4 to 8 cm segment.
ARA: anorectal angle.
EVAC: evacuation.

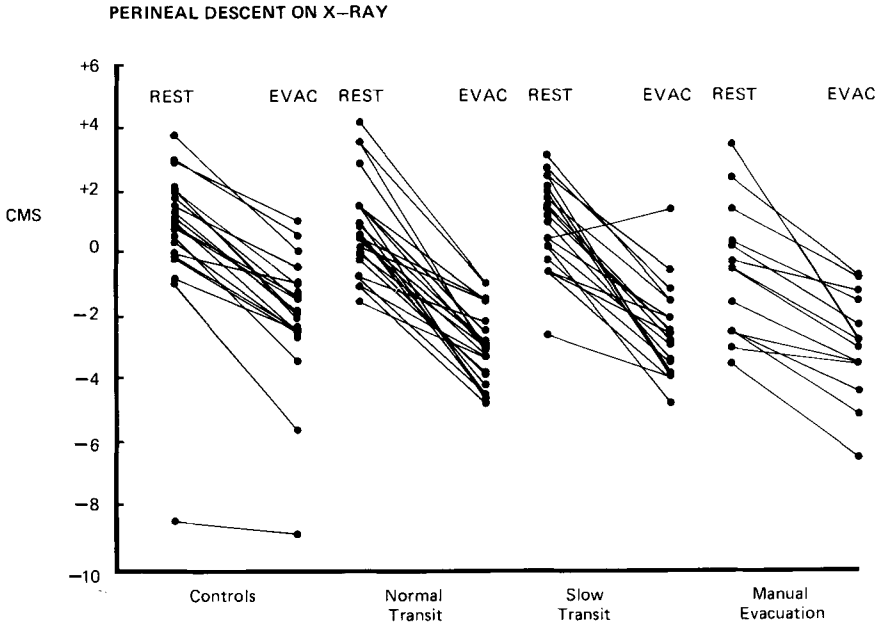

FIG. 2. Level of the anorectal junction relative to the ischial tuberosities at rest and at lowest point during evacuation of barium.

from the patients who used digital evacuation.

There was no significant difference in the emptying of the distal 4 cm and the 4 to 8-cm segments of the rectum in the control group or the normal transit group. The constipated patients with slow transit emptied significantly less barium from the distal 4 cm than the 4 to 8-cm segment of the rectum ($P < .001$). The patients who practiced manual evacuation also did not empty the distal 4-cm segment as well as the 4 to 8-cm segment ($P < .05$).

Measurement of Rectoceles: The presence and size of anterior rectocele formation is shown in Fig. 6. Rectoceles were present in most control women though barium remained in the rectocele at the end of defecation in only one of ten subjects. There was no obvious difference in

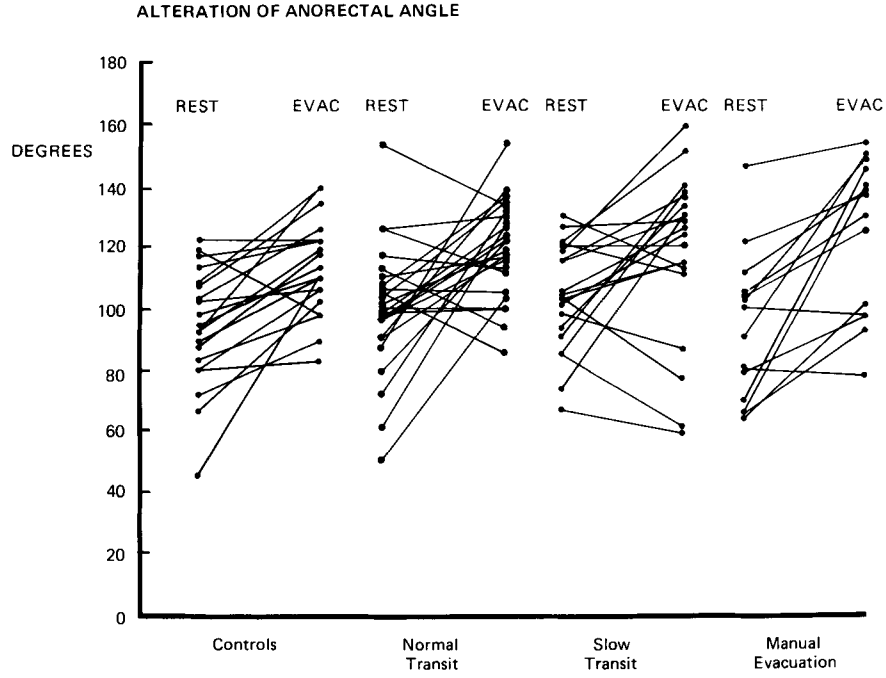

FIG. 3. Alteration of the anorectal angle, measured from the axis of the anal canal and the posterior wall of the rectum, at rest and on evacuation. EVAC: evacuation.

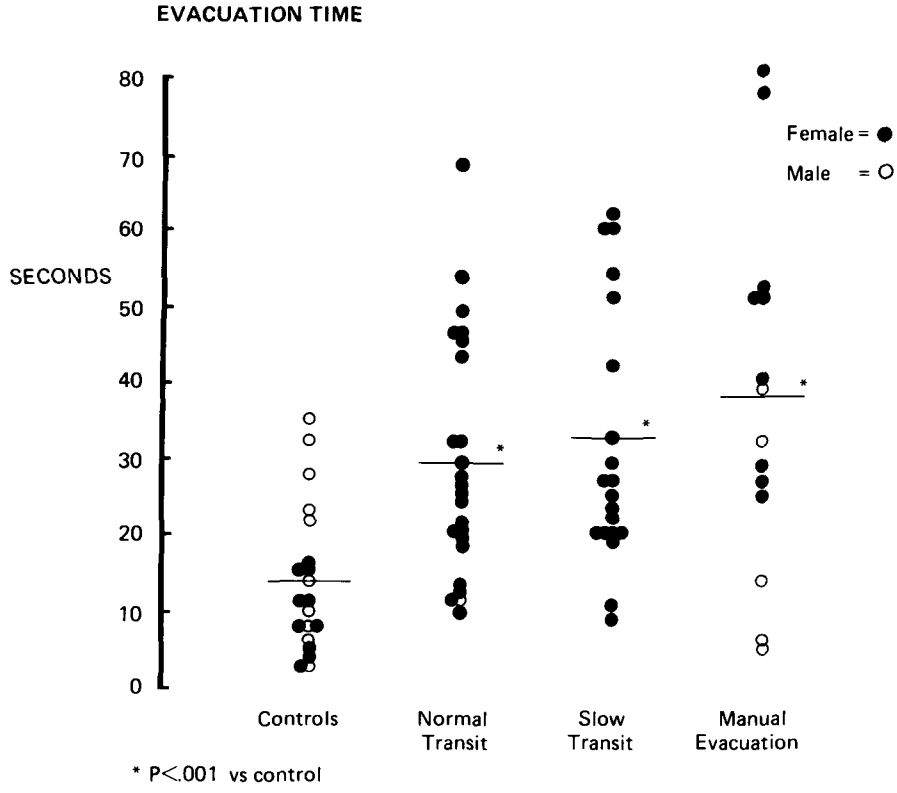

FIG. 4. Time (sec) taken to evacuate barium from the rectum.

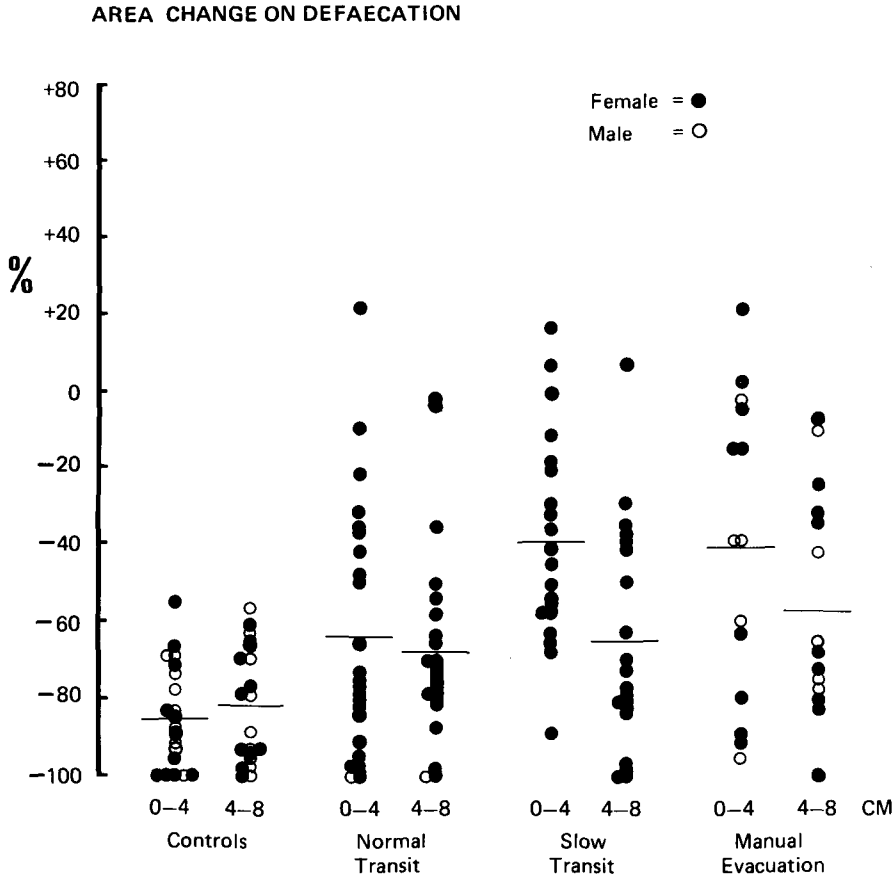

FIG. 5. Change in the area of barium during defecation measured on lateral view of the rectum. The change is measured in two sectors of the rectum, 0 to 4 cm and 4 to 8 cm proximal to the anorectal junction.

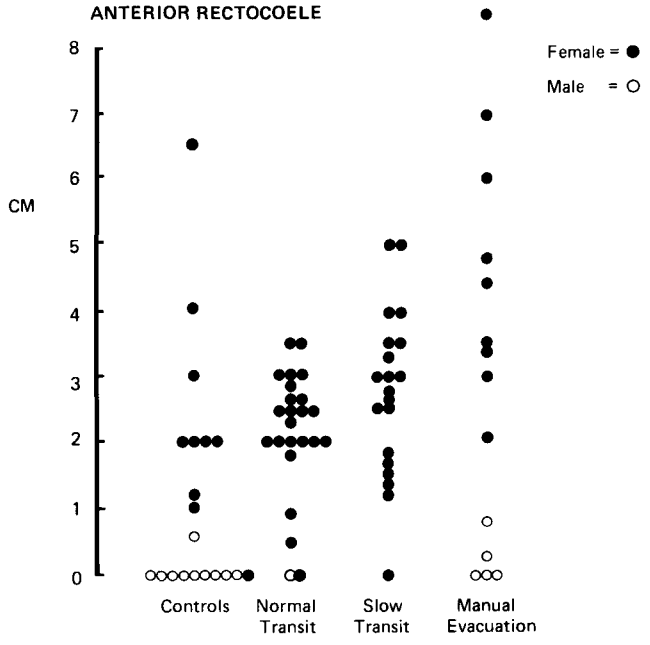

FIG. 6. Presence of an anterior rectocele measured from the extrapolated expected line of the rectum to the most distal point of the rectal wall.

the size of rectoceles in constipated women, but barium was trapped in the rectocele at the end of evacuation in only one control subject, but in nine of the normal transit group, 14 of the slow transit group, and nine in the manual evacuation group (Table 2). No male control subject or constipated patient had an anterior rectocele larger than 0.8 cm and none of the constipated males showed trapping of the barium in the rectocele.

Discussion

The technique of evacuation proctography used in these studies[14] was simpler than reported by some other authors. Preliminary observations showed that, when more than 120 ml of barium paste was injected into the rectum, some of the contrast tended to enter the sigmoid colon. Little emptying is seen there when patients are requested to empty the rectum in this radiographic examination, which only partially simulates normal defecation. The volume of contrast chosen weighs 200 gm and approximates to the upper limit of the normal daily stool weight of people in Western cultures[23] and does not overdistend the rectum, thus providing a physiologic assessment of rectal evacuation. The commercially available barium paste used to simulate semisolid rather than liquid stool is easier to use routinely than vegetable mixtures such as potato starch.

For ethical reasons, since this technique involves irradiating the pelvis, the control group consisted of subjects beyond the reproductive period. The authors' patients tended to be younger, with a preponderance of women, as in other series. A recent study by Shorvon *et al.*[24] in 48 young healthy volunteers, 23 of whom were women, has confirmed the wide range of normal values observed in this control group. Perineal descent of over 3 cm was seen in one fifth of young adults of both sexes and an anterior rectocele was identified in 77 percent of healthy young women, described as moderate to large in nine subjects. These authors saw a "high grade intussusception" in approximately 45 percent of healthy men and women, which supports the authors' use of a more stringent definition of this term.

The differences in rectal emptying times between control and constipated subjects in the present study may have been influenced by the higher proportion of males in the control group. Men tended to take longer to empty the rectum than women, however (Fig. 4). It seems unlikely that the differences in age and sex distribution between the control group and patients invalidate the comparisons made.

Previous studies of constipated subjects by evacuation proctography or a similar technique have shown greater abnormalities than were observed in this larger study of an unselected consecutive series of patients. In one report, inability to defecate or delayed defecation was noted in 19 of 35 patients; in 15 of the 19 patients the anal angle did not increase and none of these patients were able to expel any barium.[9] Similarly, the authors have studied 13 severely affected subjects, six of whom were unable to evacuate more than a few drops of barium.[3] In another series, nine of 16 patients were unable to excrete contrast, and increased activity of the striated sphincter muscles was noted by electromyography during straining in every subject.[10]

In the present series, only 14 patients evacuated less than 10 percent of the barium but, as a group, the constipated patients emptied the distal rectum less effectively and over a longer time than the control subjects. It is of interest that there was very little difference between the patients with a normal whole-gut transit rate and those with slow transit, though those with slow transit emptied the rectum less than those with normal transit, particularly the distal 4 cm. These findings suggest that many patients complaining of constipation have difficulty in defecation; in some, this may be the major problem, others may also have a disorder of colonic transit.

The measurements undertaken were often difficult to make with precision. The anorectal junction is difficult to locate when the anal canal opens during the passage of barium. Many patients delay for a short while before beginning to evacuate the barium, the time of evacuation was therefore measured from the first passage of barium. In those with difficulty in expulsion, straining was often not completed within 60 seconds, when radiographic screening was ended to avoid unnecessary irradiation.

However, the fact that they were continuing to strain for a minute or more clearly separated them from healthy persons. Alteration in the area of barium seen on the lateral view of the distal rectum as a measure of emptying is subject to the inaccuracy that a two-dimensional view, rather than a three-dimensional view, is obtained. When the rectum is empty, the walls oppose and a fold pattern is seen, but when emptying is incomplete the density of the barium precludes any assessment of depth of barium in the lateral view, so that only an outline of the area is practical. Despite these inherent inaccuracies in the method, comparison with a control group is justified as the possible errors were the same in both groups.

In this study, as in that of Reid *et al.*,[7] no difference from controls in the descent of the pelvic floor was detected, unlike the finding of Bartolo *et al.*[15] who observed no difference at rest, but a greater descent than controls in ten patients with "obstructed defecation." It was perhaps surprising that the difference between the anorectal angles at rest and on straining did not discriminate consistently between the patients and controls, though others have made the same observation.[10] Most investigators have found that the anorectal angle fails to increase on straining to the normal extent in constipated subjects[7-10] and that it is the patients who fail to increase the angle who have the greatest difficulty in rectal expulsion.[9,10] Separate analysis of the ten patients in whom the anorectal angle decreased in the series failed to show this correlation.

The present study has not shown why some patients of both sexes feel a need to digitally evacuate the rectum. Other papers have suggested that an internal intussusception is common in this group of people, but this abnormality was observed only twice among all the 58 constipated patients; both of these patients practiced manual evacuation. This difference in results probably is due to the use of a more stringent definition of intussusception than other authors.[25] Patients with anterior rectoceles frequently exhibit inversion of the anterior rectal wall as the rectum collapses at the end of evacuation, though without the downward movement of the fold required in the diagnosis of intussusception.

Evacuation proctography is a simple and acceptable method for the study of defecation in constipated patients. It is an essential technique for the demonstration of internal intussusception. In those without obvious structural abnormality, the majority of patients, using time and degree of evacuation of barium as tests of function, will be shown to have some degree of defecatory disorder. However, routine measurements of pelvic floor descent, the anorectal angle, or the width of the anal canal are not useful, though gross abnormalities should be recorded. The degree of defecatory impairment does not correlate with measurements of colonic transit, suggesting that both abnormal defecation and impaired colonic function may have a rule in the etiology of constipation.

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