A Clinico-Physiological Comparison of Ileal Pouch-Anal and Straight Ileoanal Anastomoses

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The ileal pouch-anal anastomosis improves clinical results after colectomy and mucosal proctectomy compared to the straight ileoanal anastomosis. The question was what physiologic changes brought about by the pouch led to the improvement. Among 124 patients who had had ileoanal anastomosis, 25 volunteered for a detailed clinicophysiologic evaluation. Fourteen had had the ileal pouch-anal operation a mean of 8 months previously, and 11 had the straight ileoanal operation a mean of 25 months previously. Both groups of patients had satisfactory anal sphincter resting pressures (mean ± SEM, pouch = 68 ± 8 cm H_2O, straight = 65 ± 9 cm H_2O, $p > 0.05$) and neorectal capacities (pouch = 278 ± 26 ml, straight = 233 ± 36 ml, $p > 0.05$), and all could evacuate spontaneously. However, the pouch patients had a more distensible neorectum ($\Delta V/\Delta P$ pouch = 9.5 ± 1.3 ml/cm H_2O, straight = 4.9 ± 0.9 ml/cm H_2O, $p < 0.05$) and smaller amplitude neorectal contractions (pouch = 36 ± 5 cm H_2O, straight = 90 ± 13 cm H_2O; $p < 0.05$). We concluded that the pouch-anal anastomosis increased the distensibility of the neorectum and decreased its propulsive drive, and so improved clinical results.

A RESURGENCE OF interest in ileoanal anastomosis after proctocolectomy for ulcerative colitis and familial polyposis has occurred recently. The operation, first described by Nissen,[1] and later by Ravitch and Sabiston,[2] was not widely accepted at first, because frequent stooling, incontinence, and perineal irritation marred the clinical results. However, Parks et al.[3] and others[4–7] modified the operation to include construction of an ileal pouch proximal to the ileoanal anastomosis. The pouch markedly improved the clinical results, demonstrated by fewer stools per day, better continence, and a more enhanced quality of life among 74 patients who had undergone ileal pouch-anal anastomosis than among 50 patients who had undergone straight ileoanal anastomosis.[7] The physiological changes that led to the improved clinical results with the pouch, however, were not known.

The primary aim of the present report was to define the postoperative physiology, seeking mechanisms whereby an ileal pouch-anal anastomosis provides better clinical results than does a straight ileoanal anastomosis. A secondary aim was to determine what physiologic abnormalities led to poor clinical results.

Materials and Methods

Patient Population

Among 124 patients undergoing ileoanal anastomosis for chronic ulcerative colitis or familial polyposis at the two Mayo affiliated hospitals between January 1978 and April 1982, 25 patients volunteered for a detailed clinicalphysiological evaluation in a clinical research center. Fourteen had had an ileal pouch and 11 a straight anastomosis. A spectrum of clinical results was present. Six of the patients in each group had a poor result and the rest a good result. A poor clinical result was defined by the presence of greater than 8 stools per day, major fecal leakage, and/or severe perianal irritation. No patient in either group was totally incontinent.

All patients gave informed consent for the study, which was approved by the Human Studies Committee of the Mayo Clinic. All were admitted to a clinical research center for 4 days. At the time of admission, clinical information was obtained by questionnaire and review of the medical records. Medications used to modify stool consistency and intestinal transit were continued.

Straight ileoanal group. Eleven patients (8 men, 3 women, mean age 32 years, range 21–63 years) had un-

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dergone colectomy, mucosal proctectomy, and straight ileoanal anastomosis as described by Beart et al.[8] Eight patients had had temporary ileostomies which were closed 1.5 to 3 months after colectomy and ileoanal anastomosis; 3 patients had not had a temporary ileostomy. At the time of study, intestinal continuity had been re-established a mean of 25 months (range 10–45 months). Among five patients in this group with a good clinical result, three had occasional leakage of stools at night and four had minimal perianal irritation. Six patients (4 men, 2 women) had a poor result. Five of these experienced major leakage at night with soiling of their clothing; three had the same problem by day. Three also had severe perianal irritation. In one patient, perianal irritation was the major complaint.

Ileal pouch-anal group. Fourteen patients (6 men, 8 women, mean age 34 years, range 24–50 years) had undergone colectomy, mucosal proctectomy and ileal pouch-anal anastomosis. The pouch employed was "J-shaped," similar to that described by Utsunomiya et al.[6] Each patient had had a temporary loop ileostomy which was closed 1 to 4.5 months after operation. The mean interval from closure of the ileostomy to study was 8 months (range 4–12 months). Eight patients (3 men, 5 women) had a good clinical result. Six of these had minor leakage at night and two had a similar problem during the day. Five also had minimal perianal irritation. Six patients (3 men, 3 women) had a poor result. Four of these had major leakage at night, three leaked during the day, and three also had severe perianal irritation. Two patients complained of severe perianal irritation, but had no leakage.

Clinical Tests

The patients were given a daily diet matched to their usual intake at home and containing 100 g of fat. Daily stool frequency was recorded, as was the weight of each individual movement. Episodes of incontinence and perineal irritation were noted.

Blood levels of hemoglobin, leukocytes, sodium, potassium, calcium, phosphorus, total protein, glucose, total bilirubin, serum glutamic oxaloacetic transaminase, alkaline phosphatase, uric acid, and creatinine were measured after an overnight fast. A 48-hour stool collection was made to determine the per cent of ingested fat that was absorbed. A Schilling test, with the addition of intrinsic factor, was performed to evaluate the absorption of Vitamin B-12. Transanal endoscopy of the distal bowel was performed in 9 patients with straight ileoanal anastomosis and in 13 pouch patients. The appearance of the ileal mucosa was recorded, and a mucosal biopsy was taken at approximately 10 cm from the mucocutaneous junction.

Motor Tests

Anal manometry. Pressures in the anal canal were measured using a rigid 1.2 cm diameter polyvinyl probe featuring 4 water-perfused channels (ID, 1.4 mm) with side ports 90° apart. The ports made possible the simultaneous measurement of pressures in 4 quadrants of the anal canal (anterior, posterior, right lateral, and left lateral) at the same level. Two of the side ports (diametrically opposed) could be moved independently of the remaining two, so that pressures could be measured simultaneously in both the proximal and the distal anal canal. This facility enabled the operator to record concurrently the rectal-anal inhibitory reflex (proximal anal canal) and contractile reflex (distal anal canal). At the end of the probe, a balloon was connected to a catheter which ran through a channel in the center of the probe. This balloon and catheter could be moved independently of the probe. The 4 channels were perfused with water (0.3 ml/min) using a low compliance perfusion system[9] with waterfilled strain gauges (Statham PDS) and a Gould 2600 Brush recorder (Gould Instruments, Cleveland, OH).

The patient, having evacuated the neorectum, adopted the left lateral position. The four side ports of the probe were positioned at the same level. The probe was inserted transanally for about 6 cm to a point where the side ports were just above the anal canal. The probe was then withdrawn in 1-cm steps,[10] and resting pressures in the anal canal were recorded concurrently from anterior, posterior, right lateral, and left lateral quadrants for 2 min at each station. The probe was then reinserted and the four side ports were positioned in the proximal anal canal. After recording resting pressure for 2 min, the patient was asked to squeeze on the probe, maintaining maximum effort for 15 sec. After a rest period of 3 to 4 min, squeeze pressures were recorded in the mid and distal anal canal in the same way.

Rectal-anal reflexes. To detect the presence or absence of the rectal-anal inhibitory and contractile reflexes, the probe was again positioned with the four side ports in the proximal anal canal. The right and left lateral ports were then moved distally for a distance of 1 to 3 cm, and were positioned, therefore, in the distal canal. The ileal distending balloon was positioned in the neorectum just proximal to the upper limit of the anal canal. After recording resting pressure in the proximal (anterior and posterior quadrants) and distal anal canal (right and left lateral quadrants) simultaneously for at least 2 min, 20 ml of air were instilled briskly into the balloon. If this stimulus failed to trigger either an inhibitory (proximal anal canal) or a contractile reflex (distal anal canal), the procedure was repeated after 3 or 4 min using 40 ml of air to distend the balloon.

Ileal distensibility and capacity. A 10-cm long high compliance latex rubber balloon attached to a catheter was inserted through an anoscope into the neorectum just orad to the levator muscles. The balloon was inflated serially with 10-ml increments of water at 37°C at 2-min intervals and intraluminal pressure was recorded. After 100 ml had been instilled, increments of 20 ml were used. The test was terminated when the patient complained of a sustained feeling of discomfort or nausea or an urgent need to evacuate the neorectum. The volume which produced this sensation was taken to be the maximum tolerable volume to which the neorectum could be distended. The response of the balloon alone to similar distention was measured in bath water at 37°C. The *in vitro* calibration curve was then subtracted from that obtained in the neorectum to determine the net *in vivo* response.

Ileal motility. After an overnight fast, the patients were asked to evacuate the neorectum. They were then placed in the left lateral position, and a triple channel polyvinyl catheter assembly (overall OD, 4 mm) with side ports at 5 cm, 10 cm, and 15 cm from the tip was placed in the neorectum. Each channel (ID, 0.9 mm) was perfused with water at 0.3 ml/min by means of the low compliance pneumohydraulic perfusion system, and pressures applied to the side ports were transmitted to the strain gauges and recorder. Pressure changes within the neorectum were recorded at sites 0 cm, 5 cm, and 10 cm proximal to the upper end of the anal canal for a 4 hr period with the patient in the supine position, and then for an additional hour after the ingestion of a meal containing 800 to 1,000 calories, 15% of which were protein, 35% carbohydrate, and 50% fat.

Analysis of the Motor Data

The means of the four quadrant resting pressures recorded at each station in the anal canal were calculated, and the greatest of these means was designated the maximum mean resting pressure. A similar technique was used to determine the maximum mean squeeze pressure. Measurements in the two groups of patients were compared to each other and to measurements obtained in an identical way from 18 healthy unoperated volunteers.

A positive rectal-anal reflex was defined as a reproducible 20% increase (contractile reflex) or 20% decrease (inhibitory reflex) in the resting anal sphincteric pressure immediately following balloon distention of the distal ileum. A pressure-volume curve was plotted for each patient and the distensibility of the neorectum was calculated as the reciprocal of the slope of the curve. Pressure/volume data for all patients in each group were then plotted as mean values to obtain the overall mean distensibility.

Only the motility tracing from 5 cm orad to the anal sphincter was analyzed in detail; it appeared to be most representative of neorectal motility. Both small and large amplitude distal ileal pressure waves were identified.[11] The small waves were difficult to separate from recording artefact, so they were not analyzed in detail. The large waves could be clearly separated. Their mean frequency, amplitude, and duration for each hour of study were determined, and the overall means calculated for both patient groups.

Statistical Analysis

Comparison between the ileal pouch-anal group and the straight ileoanal group were made, using the Student's t-test for unpaired data.

Results

Clinical Tests

The patterns of stooling were similar in the pouch patients and in the straight ileoanal patients. All patients were able to defecate spontaneously; none required a catheter to empty the distal bowel. The mean stool frequency in the pouch patients (mean ± SEM, 7.1 ± 0.5/24 hr; range, 4.4 to 9.5/24 hr) did not differ greatly from that in the straight ileoanal group (mean, 9.1 ± 1.0/24 hr; range, 5.0 to 15.2/24 hr; $p > 0.05$). The stool frequencies, while the patients were in the hospital, correlated closely with stool frequencies at home. The daily stool outputs in the two groups were also similar (pouch, 722 ± 91 g; straight, 547 ± 88; $p > 0.05$). Five patients in each group had episodes of incontinence and/or perineal irritation.

The hematological and blood chemical tests of both groups were within the normal range. One patient in the straight ileoanal group had impaired absorption of Vitamin B_{12} (ratio, % 57Co excreted/% 58Co excreted = 0.4) and another had poor absorption of fat (23% of ingested fat excreted in stool). No major difference in endoscopic or biopsy findings was present between pouch and straight ileoanal patients or between patients with good and poor results. Of 22 patients endoscoped, 12 had grossly normal mucosa, while 10 had slightly erythematous mucosa. The mucosa was histologically normal in 2 patients, while mild chronic inflammation was present in the remainder.

Motor Tests

Anorectal manometry. The mean maximum resting anal canal pressure in the straight ileoanal group (65.3 ± 8.8 cm H_2O) differed little from that in the pouch group (68.0 ± 7.5 cm H_2O; $p > 0.05$), but both groups had slightly lower pressures than a control population

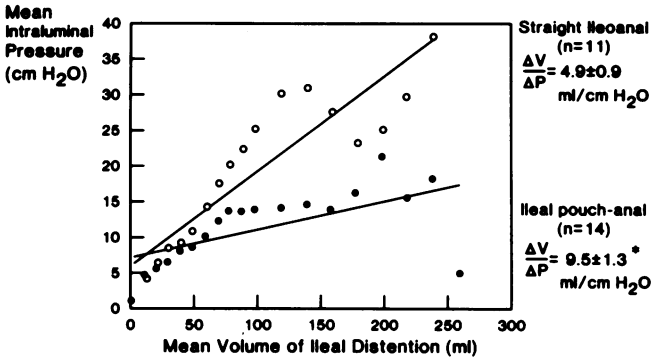

FIG. 1. Distal ileal (neorectal) pressure-volume curves after ileoanal anastomosis. Points are means of values from 11 patients in the straight ileoanal group and 14 patients in the ileal pouch-anal group. *Slopes differ between groups ($p < 0.01$).

of healthy volunteers (88 ± 6 cm H_2O, $p = 0.05$). Moreover, 3 patients in the pouch group had markedly low resting pressures (19, 35, and 37 cm H_2O) as did 3 patients in the straight group (26, 32, and 31 cm H_2O).

Little difference in maximum squeeze pressures was found between the two groups (straight ileoanal group, 192 ± 27 cm H_2O; pouch group, 142 ± 21 cm H_2O; $p > 0.05$) or between either group and the controls (166 ± 22; $p > 0.3$). One patient in the straight group had a low squeeze pressure (62 cm H_2O); 2 had low squeeze pressures in the pouch group (66 and 69 cm H_2O).

Rectal-anal reflexes. Overall, 8 of 22 patients tested (36%) demonstrated the inhibitory rectal-anal reflex, but its presence or absence was unrelated to the type of anastomosis or the functional outcome (good v poor result). Fifteen of the 22 patients (68%) had a contractile reflex; this was notably present in all straight and pouch patients with poor results. Only five patients had both reflexes.

Ileal distensibility and capacity. The reciprocal of the slope of the neorectal pressure-volume curves (*e.g.*, distensibility) in the pouch group (9.5 ± 1.3 ml/cm H_2O) was greater than in the straight ileoanal group (4.9 ± 0.9 ml/cm H_2O; $p = 0.008$) (Fig. 1). However, the maximum tolerable neorectal capacity was similar in the pouch group and the straight group (straight ileoanal group, 233 ± 36 ml; pouch group, 278 ± 26 ml; $p > 0.05$).

Ileal motility. Phasic changes in distal ileal pressure were greater in amplitude in the straight ileoanal group than in the pouch group (Figs. 2 and 3). The greater amplitude was observed during each hour of the 4-hr fasting period and during the hour after feeding ($p < 0.05$). A small increase in amplitude occurred after feeding in both straight ileoanal ($p = 0.006$) and pouch patients ($p < 0.001$). In contrast, the mean frequency of pressure waves was not consistently greater in the straight ileoanal group (9.5 ± 2/hr) than in the pouch group (6.5 ± 2/hr, $p > 0.05$) (Fig. 4). However, the frequency increased after feeding in both the straight ileoanal (25.3 ± 4/hr, $p = 0.006$) and pouch groups (19.9 ± 4/hr; $p = 0.003$). The duration of the changes in pressure was the same in both groups during fasting and after feeding (0.8 ± 0.1 min).

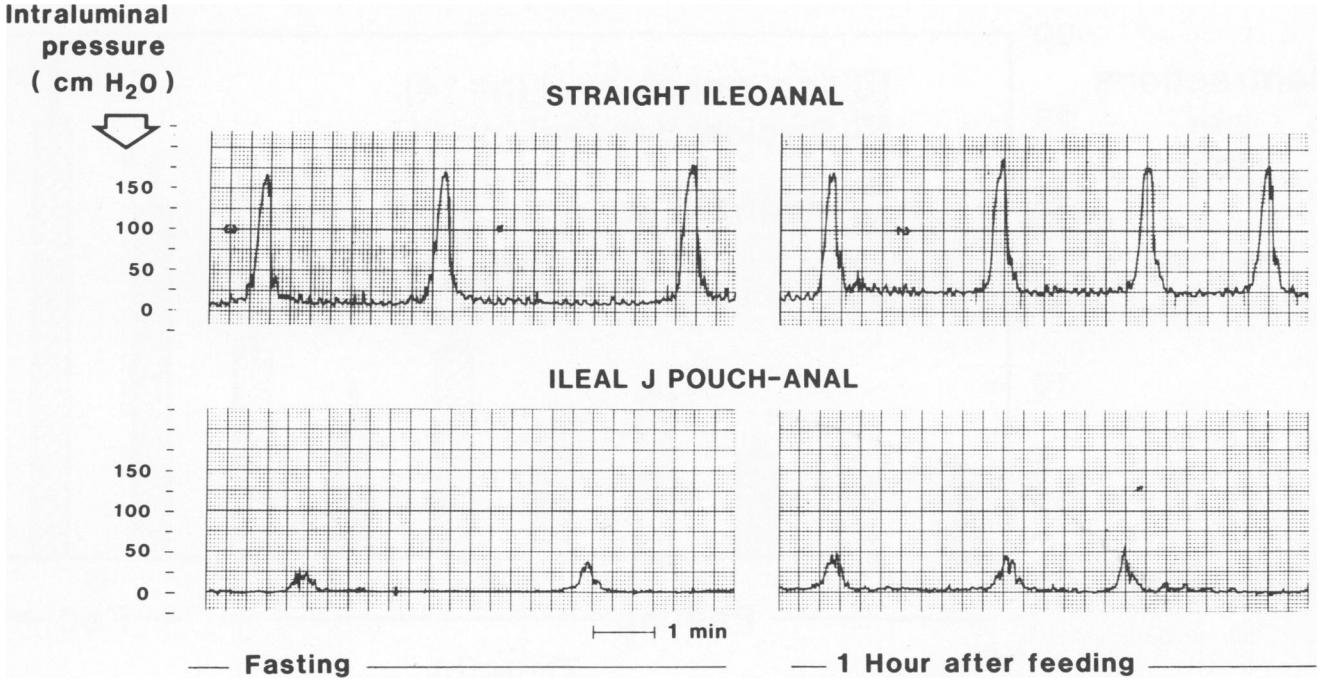

FIG. 2. Distal ileal motility tracings after ileoanal anastomosis.

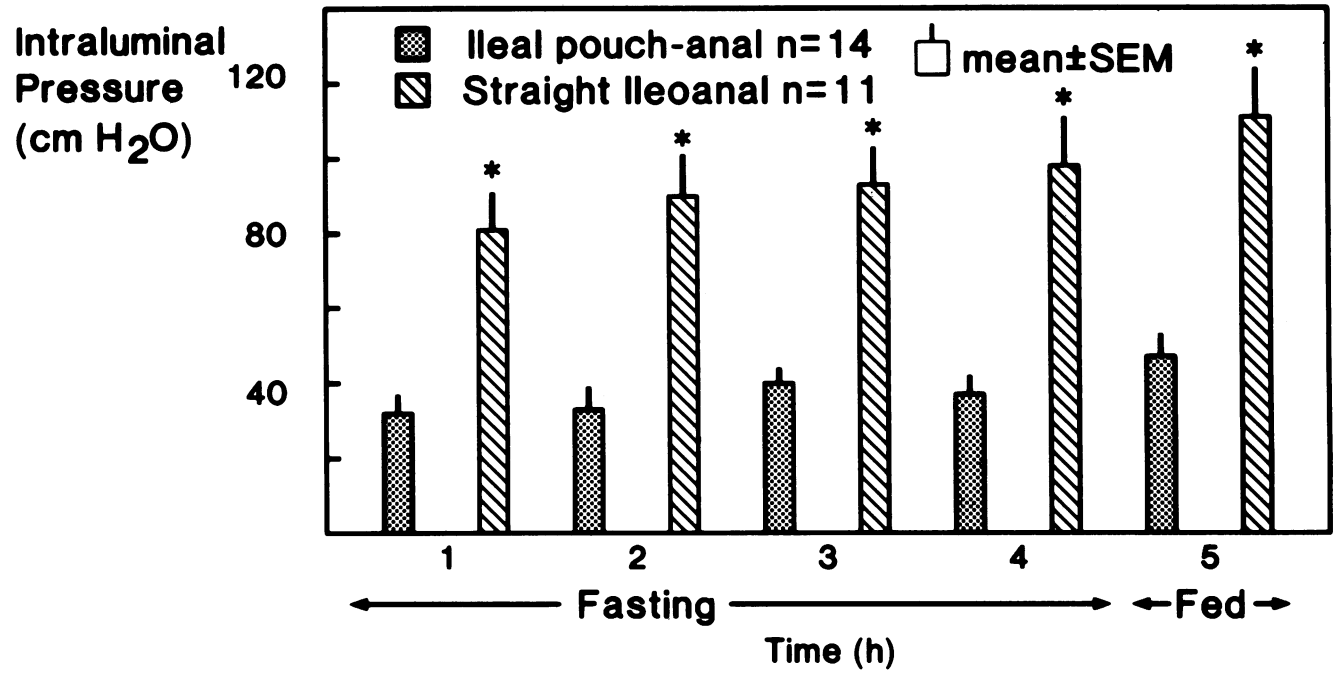

FIG. 3. Mean amplitude of distal ileal (neorectal) pressure waves after ileoanal anastomosis. *Hourly means differ between groups ($p < 0.05$). Postcibal means > fasting means within groups ($p < 0.01$).

Clinicomotor Correlation

Patients with a good clinical result had anorectal motor functions that differed slightly or moderately from those of healthy unoperated controls (Table 1). In contrast, at least one marked abnormality of anorectal function was detected by the motor tests in all 12 patients in both groups with a poor clinical result.

Discussion

Our tests showed that the patients with an ileal pouch-anal anastomosis had a more distensible distal ileum

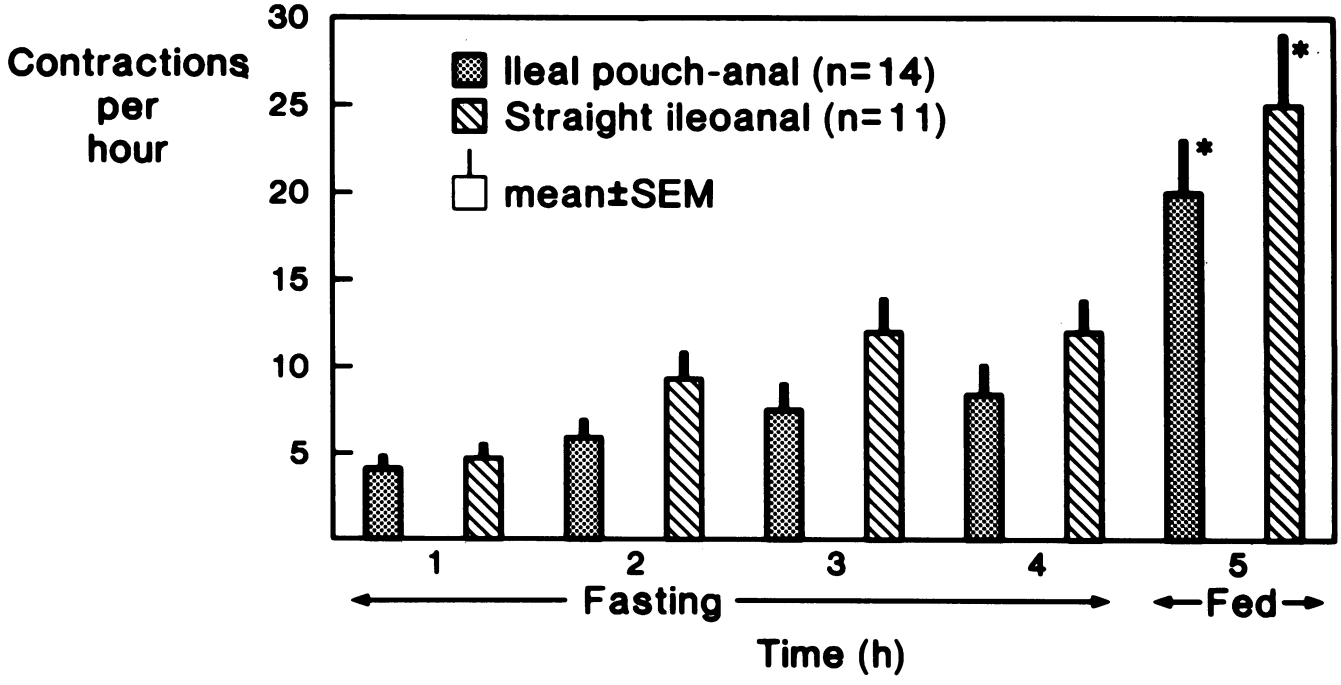

FIG. 4. Mean frequency of distal ileal (neorectal) pressure waves after ileoanal anastomosis. Hourly means are similar between groups ($p > 0.05$). *Postcibal means > fasting means within groups ($p < 0.01$).

TABLE 1. *Effect of Ileoanal Anastomosis on Anorectal Function*

Group	Pt.	Anal Sphincter: Resting pressure (cm H_2O)	Anal Sphincter: Squeeze pressure (cm H_2O)	Distal Enteric: Capacity (ml)	Distal Enteric: Distensibility (ml/cm H_2O)	Distal Enteric: Pressure waves (cm H_2O)	Clinical problem
Controls*	Mean ± SEM	88 ± 6	166 ± 22	406 ± 26	17 ± 2	10 ± 3	None
After ileoanal anastomosis							
Poor results	1	84	198	340	4	110	Frequent stools, leakage
	2	26†	138	400	5	60	Leakage, dermatitis
Straight group	3	69	259	140	5	160	Frequent stools, dermatitis
	4	91	319	140	5	110	Frequent stools, leakage
	5	32	119	460	4	100	Leakage, dermatitis
	6	103	143	140	2	200	Frequent stools
	12	STRICTURE		340	10	60	Leakage, dermatitis
	13	85	309	280	10	85	Leakage, dermatitis
Pouch group	14	88	118	130	5	31	Frequent stools
	15	19	66	220	9	24	Leakage, dermatitis
	16	37	69	280	5	23	Leakage, dermatitis
	17	35	89	120	3	24	Leakage
Good results	Mean ± SEM	73 ± 6	165 ± 21	266 ± 28	9 ± 2	49 ± 2	Minimal or no disability

* Values are means based on current tests and previous tests (12) of healthy volunteers.

† Underline highlights markedly abnormal values.

and smaller amplitude distal ileal contractions than the patients with straight ileoanal anastomosis. Most likely, the increased distensibility and the less propulsive contractile drive with the pouch contribute to the improved clinical results with the pouch.

Certain aspects of the selection of patients for study deserve comment. All 124 patients who received ileoanal anastomosis at Mayo were asked to participate, but patients with a poor result were apparently more likely to respond. Thus, the percentages of poor results among patients in this report (straight = 55%, pouch = 43%) were greater than among all patients undergoing ileoanal anastomosis at Mayo (straight ~ 50%, pouch ~ 15%).[7] However, the factors which prompted a patient's decision to enter the study were presumably identical within both groups, and our study design was not dependent on sampling each group in a representative fashion. In fact, because our secondary aim was to examine possible reasons for poor clinical results in both groups, it was helpful to receive a disproportionate number of patients with poor results.

A more serious critique is that the straight ileoanal operations were done about 18 months before the ileal pouch-anal operations. Our operative techniques had not changed greatly between the two periods to our knowledge, except for the use of the pouch. The longer postoperative period in the straight group would have allowed greater adaptation to the ileoanal operation and, hence, biased the results in favor of the straight group. However, the pouch patients had as good a sphincter and as capacious a neorectum as did the straight ileoanal patients in spite of the shorter postoperative period, and the pouch patients had a more distensible and less forcefully contractile neorectum.

We expected that the ileal pouch-anal anastomosis would preserve the anal sphincters and the neorectal-anal reflexes as well as did the straight ileoanal anastomosis, and this was the case. More surprising was the fact that the neorectum was no more capacious in the pouch group than in the straight group. The shorter postoperative follow-up in the pouch group likely accounted for this finding, because neorectal capacity tends to increase with time after both types of ileoanal anastomosis.[13,14]

A major test finding was the greater distensibility of the distal ileum in the pouch patients than in the straight group. Neal and colleagues[14] have also reported improved ileal compliance with the "S-pouch" reservoir, while Telander et al.[15] have enhanced neorectal capacity with balloon dilatations. Distention of a noncompliant bowel not only leads to discomfort, but also stimulates forceful contractions in the bowel.[16] These contractions, in turn, add to the feeling of fullness and the urge to defecate. Construction of a distensible distal ileal pouch combats these adverse sequelae.

Contractions of the ileum also appeared to influence the ability of these patients to maintain continence. Unlike the normal rectum, which reacts to distention by relaxation of its smooth muscle, the ileum contracts vigorously, driving its content distally against the resistance of the anal sphincters.[11] Although the frequency of fasting ileal waves in this report was similar after both operations, the amplitude of waves in the straight patients (90 ± 13 cm H_2O) was nearly 3 times that in the

pouch group (36 ± 5 cm H_2O). Thus, patients with a straight anastomosis needed sphincter pressures of at least 90 cm H_2O to prevent leakage. It appears that most of these patients could prevent leakage during the day by a voluntary contraction of their anal sphincters. However, at night the sphincteric resting tone could not resist the propulsive force of the ileal waves, and leakage occurred. Patients with the pouch-anal anastomosis had smaller amplitude neorectal waves. Therefore, they have less propulsive stress on their anal sphincters and, so, less leakage.

Each patient in this report with a poor result had at least one, and sometimes more, motor abnormalities which could explain their problems. For example, in one patient (patient 1) with a strong sphincter and a capacious neorectum, a highly contractile distal ileum appeared to be the abnormality responsible for a poor clinical result. On the other hand, a single motor abnormality did not necessarily produce a poor result. One patient (patient 7) with a weak sphincter had a good result, presumably because neorectal contractions were not forceful, and the capacity and distensibility of the neorectum were great. Thus, anal sphincter pressure and distal ileal capacity, distensibility, and amplitude of contractions all appear to contribute to the final clinical result in a given patient.

While rectal functions were, in general, better preserved after ileal pouch-anal anastomosis than after straight ileoanal anastomosis, the pouch did not guarantee preservation of the functions. Abnormalities in each of the motor functions we studied were present in this series of pouch patients. These abnormalities are likely to have contributed to a poor clinical result in the patients in which they occurred.

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Discussion

DR. ALEX GERBER (Alhambra, California): I would like to raise the question of pouchitis in these patients. In a series of some 150 Kock pouches, we have encountered pouchitis in 12% of the patients, usually manifested by abdominal cramps, increased output, and occasionally bleeding.

The usual explanation for pouchitis is an overgrowth of anaerobic bacteria in the reservoir, at least almost all of these patients respond rather quickly to oral metronidazole. On the face of it, I cannot see why a pouch placed deep in the pelvis would behave any differently from a pouch placed in the right lower quadrant of the abdomen, either anatomically, physiologically, or bacteriologically. And I would anticipate that the incidence of pouchitis would turn out to be the same in both groups of patients.

I raise the question because, whereas an increased output is handled rather easily with the Kock pouch by merely intubating the pouch more frequently, the patient who has an ileal pull-through operation and diarrhea essentially has a perineal ileostomy, and that is a rather unhappy situation.

I salute the authors for pursuing an operation which eliminates the Brooke ileostomy and its external appliance. In a rather large experience, I can think of no patient who is more grateful than the one who has been provided with an intraabdominal pouch of any kind, and no longer has to wear a bag filled with liquid feces 24 hours a day.

DR. R. W. BEART (Closing discussion): Certainly, at this point in time we have no procedure which will offer a patient who requires a total proctocolectomy a normal pattern of stool defecation, but there are a number of surgical alternatives emerging now which do seem to offer an improved quality of life. The ileo-anal procedure is one of these, and our experience with it has been quite favorable.

I appreciate Dr. Gerber's perceptive comments about pouchitis. We too had identified this problem in patients with a continent ileostomy, and have also noticed it in our patients with an ileo-anal procedure. We are not yet aware of the incidence of pouchitis, but it clearly occurs. Unlike our experience with the continent ileostomy, we have identified an association with specific pathogens, and the entities seem to respond to the same treatment—oral metronidazole—in virtually all cases.

This study does have some biases, in that the patients do not necessarily represent the entire spectrum of the patients that have had the procedure; but I think the findings, as outlined by Dr. Taylor, do identify at least some reasons why the pouch may contribute to the overall well-being of the patients, as opposed to the straight ileo-anal anastomosis.