

Diarrhoea after continent ileostomy*

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SUMMARY To determine the nature and frequency of malabsorption in patients with continent ileostomies, faeces and urine from 42 patients with ileal pouches and from 19 patients with conventional ileostomies were analysed and compared. The patients with conventional ileostomy were matched with patients with ileal pouches. Thirteen of the patients with pouches were found to have excessive faecal volumes which were accompanied by increased faecal losses of electrolytes, nitrogen, and fat, and by decreased vitamin B₁₂ uptake. The remaining patients with continent ileostomies had faecal and urinary outputs which were similar to those of patients with conventional ileostomies. Thus, evidence of malabsorption was found in approximately 30% of this group of patients with continent ileostomies.

In 1969 Kock¹ introduced the continent ileal pouch into abdominal surgery, as an attractive alternative to the conventional ileostomy. When such a pouch is used after proctocolectomy for the surgical treatment of chronic ulcerative colitis or familial polyposis, the patient can be rendered completely continent for stool and gas.^{2,3} The procedure involves the fashioning of a 30-40 cm segment of distal ileum into an intra-abdominal reservoir connected to the exterior by an efferent limb of 10 cm of terminal ileum. A major modification of Kock's original technique is construction of an intussusception of the efferent limb into the pouch to form a 'nipple valve', which establishes continence in most patients.^{2,3} The pouch distends ultimately to a capacity of 400-1000 ml, and the patient empties the contents by intubating the pouch at intervals that vary usually from four to 12 hours.^{1,3}

Several investigators have studied absorption in patients with continent ileostomies. Early reports showed that absorption of D-xylose, phenylalanine, fat, and water was shown to be the same in these patients as in unmatched patients with conventional ileostomies.⁴ In addition, transport of sodium, chloride, and water by mucosa of the pouch was similar to that of the normal ileum.⁵ Although

Jagenburg and his associates⁴ reported initially a 60% incidence of subnormal absorption of vitamin B₁₂, longer follow-up⁶ demonstrated subsequently that the incidence of vitamin B₁₂ malabsorption was only 10%. Moreover, direct instillation of vitamin B₁₂ and intrinsic factor into the pouch showed that the mucosa is capable of absorbing the vitamin actively.^{5,6} However, recent reports⁷⁻⁹ indicate that malabsorption may occur in some patients with continent ileostomies. Moreover, an inflammatory reaction in the pouch may be associated with an increased output of fluid from the pouch.

The present study was undertaken to compare the faecal and urine output and composition, blood chemistry, and vitamin B₁₂ absorption in patients with continent ileal pouches to those of patients with conventional (Brooke) ileostomies.

Methods

PATIENTS STUDIED

Forty-two patients (21 men, 21 women), aged 19 to 71 years, were studied three to 75 months after construction of a continent ileal pouch (Table 1). An additional 19 patients (nine men, 10 women), aged 20 to 70 years, with conventional ileostomies were studied 17 to 48 months after operation. These latter individuals were matched by sex, age, time since operation and original diagnosis to patients with continent ileostomies. The mean amount of ileum resected in the patients with continent ileostomy did not differ from that of patients with conventional ileostomy. All patients were volunteers

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Table 1 Characteristics of patient population

Group	n	Sex		Range of age (yr) (mean—33.9)	Range of mos. postop.	Original diagnosis	Cm ileum resected (mean±SE)
		F	M				
Continent ileal pouch	42	21	21	19–71 (mean—33.9)	3–75 (mean—27.9)	38 ulcerative colitis 4 polyposis	6.0±1.0
Pouch output <1000 g/d	29	17	12	19–49 (mean—31.9)	11–75 (mean—31.3)	26 ulcerative colitis 3 polyposis	4.8±0.6
Pouch output >1000 g/d	13	4	9	20–71 (mean—38.3)	3–42 (mean—20.3)	12 ulcerative colitis 1 polyposis	9.2±3.2
Conventional ileostomy	19	10	9	20–70 (mean—36.6)	17–48 (mean—30.8)	19 ulcerative colitis	6.5±1.8

*Nine patients <14cm, two >20 cm, two unknown.

and gave written informed consent to a protocol that had been approved by the Human Studies Committee of the Mayo Clinic. All were judged clinically to be well adjusted to the postoperative state. The patients were hospitalised for five days in a clinical research centre and were given constant diets of known composition, which were individually designed to be similar to their usual dietary patterns at home.

STUDIES OF ILEOSTOMY EFFLUENT

Ileostomy effluent was collected for 48 hours, and the weight of the specimen was recorded. All specimens were frozen immediately upon collection and were thawed only for homogenisation and preparation of aliquots, which were processed without delay. Stools were dried and ashed; sodium and potassium levels were measured by flame atomic absorption (Perkin-Elmer model 303) and stool chloride with a Buchler-Cotlove Electrometric Potentiometer. The faecal nitrogen level was determined using a macro-Kjeldahl technique. The fat content of effluents was determined by the method of van de Kamer¹⁰ and an output of ≤7% of the daily fat intake was considered normal.

VITAMIN B₁₂ ABSORPTION TEST

Standard Schilling tests were performed by simultaneous ingestion of 0.25 µg cyanocobalamin containing 0.8 µCi ⁵⁸Co cyanocobalamin and of 0.25 µg cyanocobalamin containing 0.5 µCi ⁵⁷Co cyanocobalamin bound to human gastric juice (Amersham Corporation Dicapac Kit). A loading dose of 1000 µg unlabelled vitamin B₁₂ was given intramuscularly 1½ to two hours after the oral dose. Urine was collected for 24 hours and radioactivity was measured (modified Canberra CI instrument). Urinary excretion of ≥ 9% of the ingested dose of each isotope was regarded as normal.

STUDIES OF URINARY OUTPUT

Urine collections were made over a 48 hour period, and volumes were noted. The pH of freshly voided

urine was determined on a Corning Model 601 Digital Ionalyzer pH meter. Sodium and potassium concentrations were measured with an IL Flame Photometer Model 143. Chloride concentrations were estimated using the method of Schales and Schales.¹¹

BLOOD TESTS

The pH was determined on venous samples using a Laboratory Instruments Model 313 pH blood gas analyser. Serum sodium and potassium were

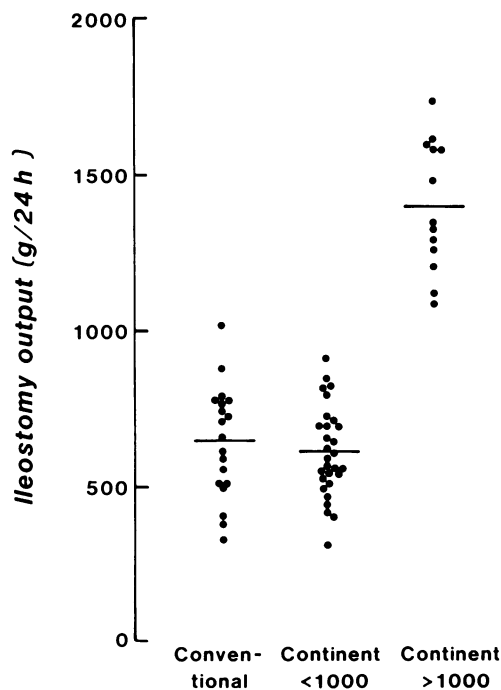


Fig. 1 Daily ileal effluent weight in patients with conventional ileostomies and in those with continent ileostomies separated into those whose output was less than or greater than 1000 g/24 hours. Horizontal lines indicate means for each group.

Table 2 Volume and composition of ileostomy output

	Conventional ileostomy* (n=19)	Continent ileostomy*	
		Output <1000 g (n=29)	Output >1000 g (n=13)
Volume (g/24 h)	650.7 ± 44.0	615.6 ± 26.6	1405.9 ± 57.4
Faecal fat (% of ingested)	3.41 ± 0.40	4.61 ± 0.50	9.62 ± 2.13
Stool Na ⁺ (mmol/24 h)	80.9 ± 7.4	78.2 ± 4.7	138.9 ± 11.5
Stool K ⁺ (mmol/24 h)	6.0 ± 0.5	10.5 ± 2.3	19.7 ± 4.8
Stool Cl ⁻ (mmol/24 h)	33.5 ± 6.1	38.9 ± 4.1	85.3 ± 12.9
Stool N ₂ (g/d)	2.12 ± 0.15	2.26 ± 0.16	4.18 ± 0.26

*Mean ± SE.

Values from conventional ileostomies do not differ from those with low output continent ileostomy ($P > 0.05$), but do differ from those with high output continent ileostomy ($P < 0.005$). Values from high output continent ileostomy also differ from those with low output continent ileostomy ($P < 0.005$).

measured on an IL flame photometer Model 143 and chloride on a Buchler-Cotlove electrometric potentiometer. Serum folate and vitamin B₁₂ were determined with a Schwarz-Mann Simul-TRAC (Dickson) kit.

Statistical comparisons were performed by Student's *t* test for unpaired data.

Results

The patients with conventional ileostomies and those with continent ileostomies had similar mean values for haemoglobin, white blood cell counts and serum levels of electrolytes, uric acid, creatinine, and folic acid. All serum vitamin B₁₂ values were also within normal limits. Most patients had a mild systemic acidosis.

Individuals with continent ileostomies were not normally distributed with respect to volumes of ileostomy effluent; they were divided clearly into two groups. Twenty-nine patients had outputs below 925 g/24 hours, while 13 individuals had outputs in excess of 1075 g/24 hours (Fig. 1). Conversely, patients with conventional ileostomy appeared to constitute a homogeneous group, with a unimodal distribution (Fig. 1).

HIGH OUTPUT CONTINENT ILEOSTOMY VS LOW OUTPUT CONTINENT ILEOSTOMY

Mean faecal output in the group of patients with low output from their continent ileostomies (616 g/24 hours) differed from that of the high output group (1406 g/24 hours; $P < 0.001$). Faecal losses of electrolytes and nitrogen (Table 2) were also significantly greater among those with large faecal volumes.

Individuals with ileal pouch outputs of less than 1000 g/24 hours had significantly lower excretion of faecal fat than did those who had outputs exceeding 1000 g/24 hours (Table 2). In six of the 13 patients who had high pouch outputs faecal fat excretion was greater than 7% of fat intake, while only four of 29 patients with lesser effluent weights had abnormally high faecal fat levels (Fig. 2).

Although the quantities of vitamin B₁₂ in the urine as measured with the Schilling test (with intrinsic factor) were significantly lower ($P < 0.025$) among patients who had high pouch outputs, none of these individuals excreted less than 9% of the ingested dose, the lower limit of normal for this test (Fig. 3).

Urine volumes were not different between these groups (Table 3). However, the patients with high pouch outputs excreted urine with a lower pH (5.42, SE range 5.35–5.52 vs 5.63, SE range 5.58–5.68, $P < 0.025$), and lesser amounts of sodium and chloride (Table 3). Blood pH was 7.31 (SE range 7.30–7.32) in those with high pouch outputs, and

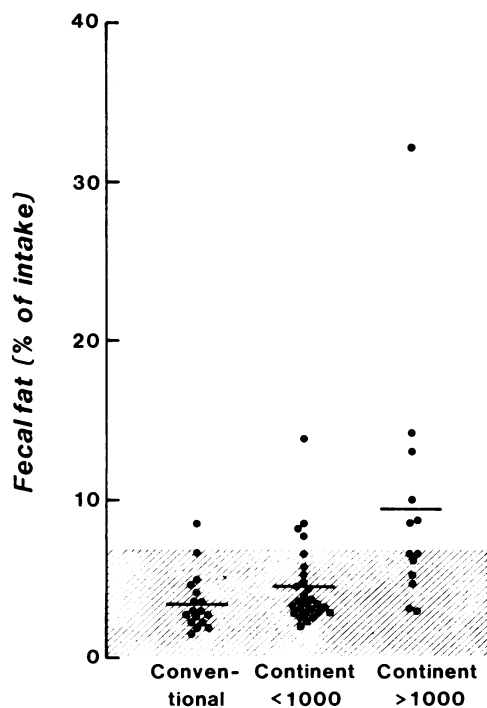


Fig. 2 Faecal fat excretion expressed as percentage of dietary fat intake in patients with conventional ileostomies and patients with continent ileal pouches whose output was less than or more than 1000 g/24 hours. Means are indicated by horizontal lines and normal range by the hatched area.

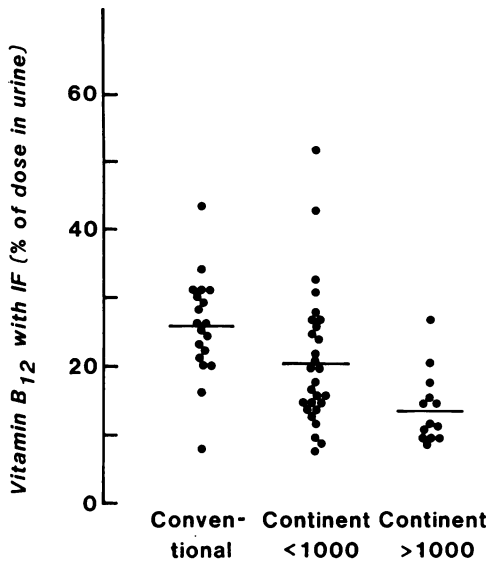


Fig. 3 Schilling test results in patients with conventional ileostomies and those with continent ileostomies whose daily outputs were less than or greater than 1000 g/24 hours. Horizontal lines represent group means. Data are for vitamin B₁₂ with intrinsic factor (IF).

this was significantly lower ($P < 0.05$) than the value of 7.35 (SE range 7.34–7.35) obtained in individuals with low pouch outputs.

Fluid and sodium intakes for patients with high pouch outputs were 2057 ± 201 ml and 136 ± 10 mmol respectively compared with 2094 ± 23 ml and 132 ± 8 mmol for those with low outputs. Dietary fat intake was 87 ± 5 g among those with outputs

of greater than 1000 g/24h and 86 ± 3 g among those with lower outputs. These data were not different between groups.

CONVENTIONAL ILEOSTOMY VS LOW OUTPUT CONTINENT ILEOSTOMY

A comparison of the 29 patients with low pouch outputs and those with conventional ileostomies revealed that these two populations had virtually identical ileal outputs. Weight of effluent, stool electrolytes and nitrogen, faecal fat, and Schilling tests were not different between groups (Table 1). Urinary output of potassium was lower in patients who had ileal pouches than in those with conventional ileostomies. Otherwise, urinary outputs were the same in these two groups. Serum pH was not different in these patients.

Dietary fluid, sodium, and fat intakes were not different between these groups, being 1896 ± 117 ml, 123 ± 9 mmol, and 85 ± 4 g respectively in patients with conventional ileostomies and 2094 ± 23 ml, 132 ± 8 mmol, and 86 ± 3 g in patients with low output continent ileostomies.

CONVENTIONAL ILEOSTOMY VS HIGH OUTPUT CONTINENT ILEOSTOMY

The patients with ileal pouch outputs exceeding 1000 g/24 hours had higher faecal excretion of electrolytes, nitrogen, and fat than did those with conventional ileostomies (Table 1). In addition, the group with high ileal outputs had less uptake of vitamin B₁₂ ($P < 0.025$) (Fig. 3).

Although the volume and pH of urine were not different in these two groups, the individuals with continent ileostomies excreted less sodium, potassium and chloride (Table 3). Blood pH was lower

Table 3 Volume and composition of urinary output

	Continent ileostomy*		
	Conventional ileostomy* (n=19)	Output <1000 g (n=29)	Output >1000 g (n=13)
Urine volume* (ml)	1305.9 ± 96.9	1302.7 ± 127.8	1120.8 ± 137.6
Urinary Na+* (mmol/24 h)	65.8 ± 8.1	62.1 ± 5.6	30.4 ± 11.3
Urinary K+* (mmol/24 h)	73.6 ± 3.3	57.4 ± 3.0	59.7 ± 1.8
Urinary Cl-* (mmol/24 h)	105.3 ± 8.8	94.6 ± 6.0	70.0 ± 13.9
Urine pH†	5.44	5.63	5.42

*Mean ± SE; comparisons not shown have $P < 0.05$.
 †Calculated from concentration of H⁺ (see text).

(7.31; SE range 7.30–7.32) in patients with continent ileostomies, compared with those with conventional ileostomies (7.36; SE range 7.35–7.37; $p < 0.05$).

Dietary intakes of fluid, sodium, and fat did not differ between groups.

Discussion

These results show that patients with continent ileostomies do not represent a homogeneous group, but instead include two separate populations based on output from the pouch. One group is characterised by low ileostomy output, less than 1000 g/24 hours, and all their values are essentially identical to those in patients with conventional ileostomies. These patients are similar to those described in previous reports from Kock's laboratory,^{4,12} and from this Unit,⁵ both of which suggest that the absorptive function of the small intestine is normal in most patients with continent ileostomies. In contrast, the second, smaller group of patients with continent ileostomies, those with pouch outputs in excess of 1000 g/24 hours, had greater quantities of electrolytes, nitrogen, and fat in the faeces, lesser uptakes of vitamin B₁₂, a lower urinary pH, less urinary excretion of sodium and chloride, and a lower blood pH than their counterparts with low outputs from their pouches. Halvorsen *et al.*⁸ and we⁹ have described previously patients with continent ileostomies who had 'diarrhoea'.

The cause of high faecal output in these patients with continent ileostomy remains to be determined. Our data do not suggest that ileal resection is an important factor. For, although two of the patients in the high output group had more than 20 cm of ileum resected at proctocolectomy (23 and 35 cm) and none of those in the low output category had more than 11 cm resected, the two patients with larger ileal resection showed no greater malabsorption than did the other 11 patients. Hill and colleagues¹³ have identified an association between high volume output and resection of more than 30 cm of ileum in patients with conventional ileostomies. Moreover, the slightly shorter postoperative period observed in patients with high output (Table 1) seems an unlikely cause. Longer term follow-up of many of these patients indicates that the high output state persists for two years or more. In addition, non-specific ileitis within the pouch, which has been implicated as a cause of diarrhoea in patients with continent ileostomies,^{8,14} is unable to explain all our findings. In our series, mucosal inflammation was identified in the pouches of patients with low output as well as those who had diarrhoea.⁹

Bacterial overgrowth is another possible explana-

tion for the diarrhoea. Schjønby and co-workers⁷ identified bacterial overgrowth of the reservoir in four patients who also had evidence of vitamin B₁₂ malabsorption. In addition, one of these patients had an increased faecal fat excretion. All of their patients responded to antibiotic therapy, as did several patients in Halvorsen's study.⁸ Gelernt¹⁴ also encountered patients with superficial inflammation of the reservoir which was characterised by diarrhoea and bacterial overgrowth in the pouch; this was corrected also by antibiotics.

Thus, it is possible that bacterial overgrowth is responsible for the diarrhoea observed in the present study. Subsequent treatment of several of our patients with antibacterials has reversed the malabsorption, which also has other features of the 'blind loop syndrome' (unpublished observations). Finally, although it should be stressed that most of the patients who had malabsorption were asymptomatic, the long-term effects constitute a potentially important medical problem, given that a period of 30–40 years of life with the pouch is to be anticipated.

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