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Fat-reduced diet in the symptomatic treatment of small bowel disease

Metabolic studies in patients with Crohn's disease and in other patients subjected to ileal resection

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SUMMARY Thirteen patients suffering from Crohn's disease or subjected to small bowel resection were studied under metabolic ward conditions for an average of 32 days. Most of these patients had chronic, severe diarrhoea and varying degrees of steatorrhoea. All were studied at two levels of fat intake, 100 g and 40 g daily.

After the introduction of the low-fat diet, there was a marked reduction in the faecal excretion of water and sodium in most patients and 10 of them passed solid faeces. Two other subjects improved only after the addition of cholestyramine. In one patient with an ileostomy, no improvement occurred. On the low-fat diet, there was a positive balance of nitrogen and potassium in many cases. Faecal fat excretion decreased, but there was no change in the fractional absorption of fat.

The most gratifying improvement was seen in patients with a functioning gallbladder. Previous resection of the colon seemed to limit the reduction of faecal water and sodium excretion which followed the reduction in fat intake.

A fat-reduced diet is recommended in the symptomatic therapy of chronic diarrhoea in patients suffering from diseases of the ileum.

Chronic diarrhoea, which often occurs in Crohn's disease and after a small bowel resection, may present a challenging therapeutic problem. In these conditions, malabsorption of fat and concomitant diarrhoea are often caused by an extensive reduction in the small bowel absorptive surface. Severe diarrhoea, with or without steatorrhoea, also occurs after resection of the terminal ileum only (Kalser, Roth, Tumen, and Johnson, 1960). Under these conditions, diarrhoea is thought to be caused by bile acid malabsorption and by a resulting exposure of the colonic mucosa to these salts (Hofmann, 1967).

Under the above conditions, the use of a fat-reduced diet has been recommended by several previous authors (Haymond, 1935; Crohn, 1949; Berman, Ulevitch, Haft, and Lemish, 1950) but systematic studies have been few and the results contradictory (Booth, MacIntyre, and Mollin, 1964; Scheiner, Shils, and Vanamee, 1965; Bochenek, Rodgers, and Balint, 1970; Dvorský, 1970). Furthermore, as strict adherence to a fat-reduced diet has often been regarded as difficult, this treatment has not gained general acceptance.

Our previous favourable experience with a low-fat diet in Crohn's disease and after ileal resection (discussed by Andersson, 1973) encouraged us to further studies on the effect of a reduction in the dietary fat intake in patients with severe Crohn's disease as well as in patients subjected to small bowel resections necessitated by other disorders. The purpose of this study is to report clinical data and the results of metabolic studies in 13 patients studied on a high-fat diet (100 g/day) as well as on a low-fat diet (40 g/day).

Material

Eleven patients with Crohn's disease and two patients previously subjected to ileal resections for other

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Patient	Sex	Age	Diagnosis	Duration of Symptoms	Length of Small Bowel Resection		Anastomosis	Gall-bladder Disease[1]	Nephro-lithiasis
					Jejunum	Ileum (cm)			
M 158 (a)	M	61	Crohn's disease	36		35	Ileum-transverse colon	−	+
M 164 (b)	F	27	Crohn's disease	18		50	Ileum-caecum	(+)[x]	
M 170 (c)	M	52	Trauma	6		135	Ileum-caecum	+	
M 179 (d)	F	38	Crohn's disease	9		60	Ileum-transverse colon	+	
M 185 (e)	M	25	Crohn's disease	10	160	35	Ileum-transverse colon	−	
M 191 (f)	M	33	Crohn's disease	7		140	Ileostomy	+	
M 195 (g)	M	19	Crohn's disease	2		—	None	−	
M 198 (h)	M	27	Crohn's disease	13		125	Ileum-transverse colon	−	
M 203 (i)	F	61	Crohn's disease	16		100	Ileum-transverse colon	+	
M 209 (j)	F	33	Crohn's disease	18		125	Ileum-ascending colon	+	
M 210 (k)	F	63	Ileus	13		55	Ileum-caecum	−	+
M 211 (l)	F	24	Crohn's disease	2		—	None	(+)[xx]	
M 216 (m)	M	34	Crohn's disease	10	40	150	Ileum-transverse colon	−	

Table I *Summary of relevant clinical and laboratory data on the series of patients*

[1] − = normal radiograph
\+ = cholecystectomy
(+)[x] = gallbladder not opacified at oral cholecystography
(+)[xx] = cholelithiasis in functioning gallbladder
[2]c = contaminated
[3]n = normal
[4]only 5 g d-xylose orally

reasons were admitted to our metabolic ward (table I).

All patients with Crohn's disease had ileal involvement, and in nine of them an ileal resection had been performed. The diagnosis of Crohn's disease was made either on the basis of operation findings in nine patients or it was highly probable as judged by *x*-ray examinations in two. In patient M 170, the ileum had been resected following damage to a mesenteric blood vessel in a car accident. In patient M 210, the distal ileum had been removed at an operation for ileus caused by irradiative damage to the gut. All patients had frequent diarrhoea except M 209 who passed only one loose stool each morning.

The clinical data for the 13 patients are given in table I. The number assigned to each patient is identical to our metabolic ward registration number. There were six women and seven men. The mean age was 38 years. The mean duration of symptoms in the group was 12 years. Signs of malnutrition (reduced body weight, reduced serum albumin and/or abnormal electrolytes) were common. In five patients, cholecystectomy had been performed after the start of the bowel disease. Another patient had no opacification of the gallbladder as revealed at cholecystography and one had a gallstone. Two had had nephrolithiasis. Biopsies performed with a peroral biopsy tube (Watson) at the duodenojejunal junction showed normal bowel mucosa in all patients. The trypsin activity in the duodenal juice was normal in 11 patients studied. Most patients showed a pathological Schilling test and/or d-xylose absorption.

Medical Treatment

All medicaments were withdrawn in the study except codeine for M 191 and M 210. Intravenous magnesium therapy was given to M 158 because of hypomagnesaemia and to M 210 who also was given sodium bicarbonate because of renal tubular acidosis. Furthermore, some patients received vitamins and iron. In two patients, M 164 and M 179, Cuemid (cholestyramine) had to be introduced after four periods on a fat-reduced diet. A dose of 4 g, two or three times a day, was given.

Diets

On the basis of the results of a pilot study (Andersson, 1973) we decided to study our patients at two fat intake levels: 100 g and 40 g. In the present study, the daily mean intake of energy and nutrients of the patients at home was estimated from their dietary histories (the intake of energy, protein, and fat is given in table II). From these histories, individual menus were worked out according to the patient's taste and appetite. The same menu was used every day for each fat level and was prepared according to metabolic ward conditions (Isaksson, Sjögren, and Weimers, 1965). The menus were regarded to be sufficient with respect to energy and nutrients for a sedentary hospital life. The fat content of the diet during the first two to four four-day periods was fixed at 100 g a day, high-fat diet, later reduced to 40 g a day, fat-reduced diet. The fat-reduced diet was given for 16 to 24 days. In patient M 203 only a 12-day study was performed.

Weight/ Length (kg/cm)	*Total Body Potassium (m-equiv)*[2]	*Total Body Water (l)*[2]	*B_{12} Absorption (%)*	*Urinary D-xylose Excretion (n > 5 g/5 hr)*	*Alkaline Phosphatase (n ⩽ 8 IE)*[2]	*Albumin (n ⩾ 3·8 g/100 ml)*[2]	*Serum Mg (n ⩾ 1·4 m-equivl)*[2]	*Other Low Electrolytes*
55/166	2560	40	0	n	n	2·4	0·7	Ca 3·0
48/162	1650	23	1	n	9	3·8	1·3	K 3·1 Ca 4·5
65/172	3520	47	1	3·3	n	n	1·2	K 3·8
49/169	2500	36	15	5·0	n	n	n	Na 138 Ca 4·5
61/177	3060	48	8	n	n	n	n	Na 136
58/170	3430	38	2	3·8	n	n	n	Na 135
57/175	2990	48	10	n	n	3·4	1·3	Na 138 Ca 4·4
76/179	3700	56	1	n	13	3·5	n	Ca 4·1
52/167	2080	33	0	3·2	9	n	1·0	
52/163	2110	28	2	3·4	n	n	n	
31/162	1290	25	1	0·54	n	3·3	1·1	Na 139 Ca 4·5
56/160	C	C	1	4·9	n	3·7	1·2	Na 137
65/183	C	C	—	4·5	n	n	n	Na 138 Ca 4·5

Table I *Summary of relevant clinical and laboratory data on the series of patients*

The fat-reduced diet was composed by reducing butter, margarine, and oil to a total of 10 to 15 g/day. Fats with polyunsaturated fatty acids dominated. Boiling and grilling were preferred and frying was avoided. To compensate for the caloric loss caused by the fat reduction, proteins and carbohydrates had to be increased. Lean meat and fish were used in high quantities. Ordinary milk was changed to skim milk. Potatoes, rice, spaghetti, fruit, and vegetables (when tolerated) were used in relatively large quantities. Between meals, bread without butter, but with lean meat, low-fat cheese, or marmalade was served. When eggs were used in preparing food the yolk was discarded.

After the study dietary prescriptions for 40-g fat diets were worked out for each patient by a trained dietitian. The mean polyunsaturated fat content of these prescriptions turned out to be 3·6 g/day (range 1·3-5·2 g/day). The diets were adequate with regard to their content of essential nutrients, ie, they corresponded to the recommendations of the Swedish expert group for the coordination of hospital diets (Isaksson, 1973).

Methods

The balance studies were performed during four-day periods according to Isaksson and Sjögren (1967), using carmine red as markers of faeces. Faeces were homogenized as described by Isaksson (1962). Food mixtures identical to the patient's menus were prepared for analysis and were then homogenized (Isaksson, Sjögren, and Weimers, 1965). Representative samples of homogenized food and faeces were freeze dried before being analysed. For nitrogen analysis, aliquots of freeze-dried food and faeces were predigested with sulphuric acid and hydrogen peroxide. A Technicon AutoAnalyzer with a Helix digestor according to the method of Marten and Cantanzaro (1966) was used to determine nitrogen.

Patient	*Kcal*	*At Home*		*Kcal*	*High-fat Diet*		*Kcal*	*Fat-reduced Diet*	
		Fat (g)	*Protein (g)*		*Fat (g)*	*Protein*[1] *(g)*		*Fat (g)*	*Protein*[1] *(g)*
M 158	4750	225	180	2400	95	120	2700	40	155
M 164	3450	150	70	2000	100	70	1700	40	70
M 170	3800	175	120	2750	100	130	2850	40	160
M 179	3350	155	100	2100	100	70	2200	40	100
M 185	3100	155	105	2350	90	85	2150	40	95
M 191	4250	185	115	3050	105	110	3050	40	170
M 195	2800	90	100	2650	100	75	3150	40	145
M 198	3550	170	95	3250	100	145	2850	45	145
M 203	2600	120	80	2200	100	70	1700	40	75
M 209	2450	140	45	2100	95	75	2000	40	75
M 210	2500	170	55	1950	100	70	1800	40	80
M 211	2900	150	90	2250	100	90	2250	40	110
M 216	3260	145	145	3050	100	135	3050	40	150
Mean	3290	155	100	2450	100	95	2420	40	120

Table II *Calculated dietary intake of energy, fat, and protein in 13 patients with ileal disease*

[1]In the nitrogen balance studies periodic analyses of the nitrogen content of the diets were performed and used in the calculations.

The same digest was used to determine potassium in the diet (Eppendorf flame photometer). Potassium in faeces and sodium in the diet and faeces were determined by flame photometry after extraction with 0·75 N nitric acid. To determine calcium (Isaksson, 1968) and phosphorus (Fiske and SubbaRow, 1925) the freeze-dried samples of diet and faeces were dry-ashed at +500°C and dissolved in 0·1 N HCl. The fat content of the diet was calculated using food composition tables (Abramson, 1971). The fat content of the faeces was determined according to the method of Kamer, Huinink, and Weyers, 1949.

Except in the first three patients (M 158, M 164, and M 170) the total body potassium was determined in a whole body counter (Arvidsson, Sköldborn, and Isaksson, 1972). Determinations of total exchangeable potassium in the first three patients and of the total body water in all the patients were performed by using an isotope dilution technique (42 K and THO) as described by Isaksson (1967).

Results

The general condition improved considerably in most patients on the fat-reduced diet. Two patients (M 164 and M 179), however, also required the addition of cholestyramine. Three patients gained weight considerably (4 kg in one month). The mean weight gain was 1·5 kg despite a caloric intake much lower than the patients had taken at home (table II). The fat intake at home averaged 150 g, while the protein intake was of the same amount as in the study.

STEATORRHOEA, DAILY NUMBER OF BOWEL MOVEMENTS, AND FAECAL EXCRETION OF WATER

On a daily intake of 100 g fat (high-fat diet), the mean daily fat excretion for the group was 23 g (fig 1). Eight patients showed marked steatorrhoea (15-55 g/day) but, in four subjects, the average fat excretion was less than 12 g/day. Introduction of the low-fat diet (reduced-fat diet) lowered the faecal fat excretion to an average of 10 g/day. During the last four-day period of the study the mean excretion of fat decreased to 9·0 g/day, corresponding to 23% of the intake. On the fat-reduced diet, the fat excretion was less than 12 g/day in 11 patients but amounted to 32 g in M 210. In two subjects, M 164 and M 179, the fat output increased following the administration of cholestyramine.

On the high-fat diet, all patients showed watery diarrhoea and the number of daily stools varied considerably (1·2-9·5). There was often an immediate decrease in the number of bowel evacuations after the start of the fat-reduced diet, and all patients except three passed formed faeces. Patients M 164 and M 179 passed solid faeces also when given

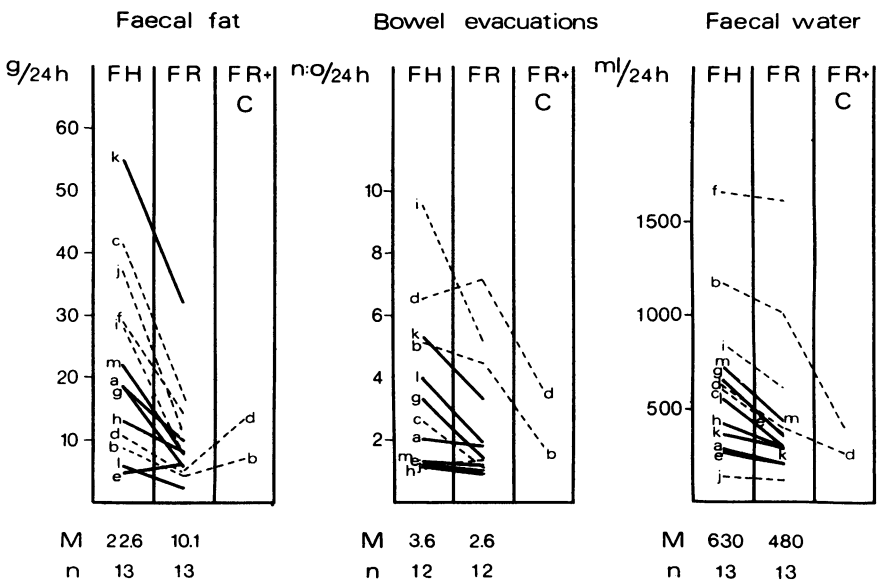

Fig 1 *Faecal fat excretion, incidence of bowel evacuations, and faecal water output on a diet of 100 g fat (FH), 40 g fat (FR), and 40 g fat with added cholestyramine (FR + C) in 13 patients with (—) or without (— — —) a functioning gallbladder.*

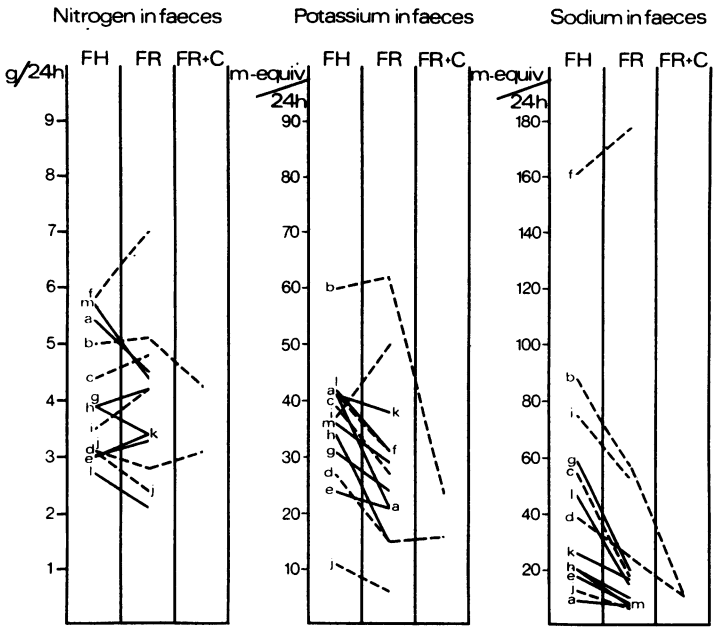

Fig 2 *Faecal nitrogen and electrolytes on a diet of 100 g fat (FH—), 40 g fat (FR), and 40 g fat with added cholestyramine (FR + C) in 13 patients with (—) or without (— — —) a functioning gallbladder.*

cholestyramine. Patient M 191, who had been subjected to colectomy, continued to have a watery ileal effluent. On the fat-reduced diet, eight of the 13 patients showed only two daily bowel movements or less.

All patients except M 209 initially passed large volumes of faeces (300-1700 ml/day). After the introduction of the fat-reduced diet, there was a marked reduction in the faecal water excretion in those patients who excreted more than 300 ml/day water when taking the high-fat diet. In the colectomized patient M 191, however, the faecal water excretion did not change significantly. For the group as a whole, the average decrease in water excretion amounted to 29% (patient M 191 excluded). A comparison between the periods on the high-fat diet and the last four-day period on the fat-reduced diet showed this figure to be 36%.

FAECAL NITROGEN AND ELECTROLYTES

On the high-fat diet, the faecal excretion of nitrogen was high in all patients and varied between 2·7 and 5·8 g/day (fig 2). In six subjects, the faecal nitrogen excretion exceeded 25% of the intake. After the introduction of the fat-reduced diet, all patients still showed an abnormally high nitrogen excretion of 2·1 to 7·0 g/day. As the protein content of the fat-reduced diet was increased in most cases (table II), the fraction of ingested nitrogen excreted with the

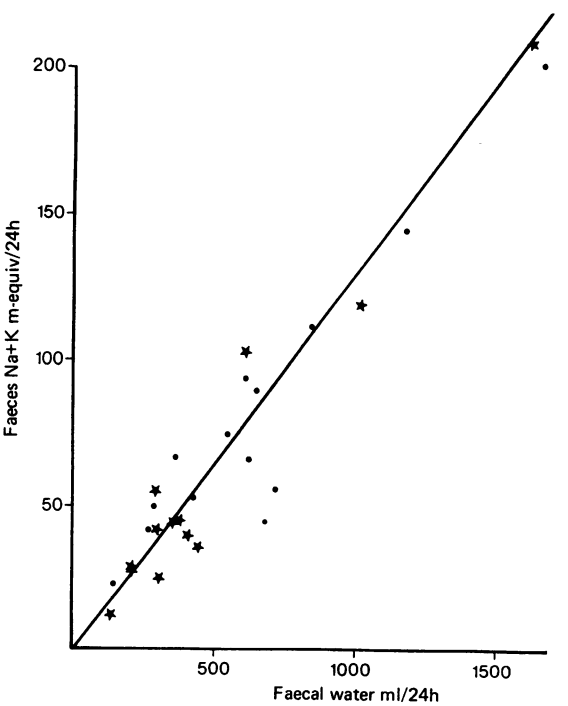

Fig 3 *Relation between faecal electrolytes and faecal water on a diet of 100 g fat (dots) and 40 g fat (stars).*

faeces decreased and amounted to at least 20% of the intake.

On the high-fat diet, the faecal excretion of potassium was also abnormally high in all cases except M 209 and ranged from 24 to 60 m-equiv/day. Although it decreased somewhat (mean: 10 m-equiv/day) in all patients except two (M 164 and M 210), the potassium excretion was still high in all subjects on the fat-reduced diet.

The faecal sodium excretion was high in all patients and varied between 9 and 161 m-equiv/day (normal value 2-m-equiv/day). On the fat-reduced diet, it decreased in all subjects except M 191 and amounted to a mean of 11% of the intake in the other patients. There was a highly significant correlation between the electrolyte content and the water content of the faeces before as well as after the introduction of the low-fat diet (fig 3).

NITROGEN AND POTASSIUM BALANCE STUDIES

The nitrogen balance was positive in all patients during the whole study except in M 158 who was in a slightly negative balance on the high-fat diet (table III). The protein content of the fat-reduced diet was higher in most cases (table II). After the introduction of this diet, the nitrogen balance improved in 11 of 13 subjects.

The total body potassium increased in 12 patients, the increase being considered significant in five subjects (M 158, M 170, M 185, M 195, and M 198). A theoretical nitrogen balance can be calculated on the assumption that the increase in the body potassium was caused by an increase in the body cell mass and that 1 g of nitrogen corresponds to 3 m-equiv of potassium. The difference between the nitrogen balance actually measured and the theoreti-

Patients	*Diet*	*Days*	N_{cum} *(g)*	ΔK_e*(m-equiv)*	Na_{cum}*(m-equiv)*	ΔBW *(kg)*
M 158	HF	12	− 5		+ 125	−1·1
	FR	28	+ 60		+ 350	+1·4
	S:a	40	+ 55	+ 480 (40 d)	+ 475	+0·3
M 164	HF	8	+ 20		+ 55	−0·5
	FR	16	+ 50		+ 145	−0·4
	FR+C	4	− 5		− 60	−0·3
	S:a	28	+ 65	+ 240 (21 d)	+ 140	−1·2
M 170	HF	12	+ 15		+ 45	−0·5
	FR	24	+125		+ 735	+1·0
	S:a	36	+140	+ 460 (33 d)	+ 780	+0·5
M 179	HF	8	+ 20		+ 195	+0·5
	FR	20	+ 65		+ 270	−0·9
	FR+C	8	+ 20		+ 65	−0·5
	S:a	36	+105	+ 210 (34 d)	+ 530	−0·9
M 185	HF	12	+ 75		+ 300	+0·8
	FR	16	+115		+ 340	−0·4
	S:a	28	+190	+ 300 (21 d)	+ 640	+0·4
M 191	HF	12	+ 20		+ 50	+0·8
	FR	24	+175		+1310	+3·3
	S:a	36	+195	+ 90 (29 d)	+1360	+4·1
M 195	HF	12	+ 20		+ 535	+1·1
	FR	20	+125		+ 730	+3·1
	S:a	32	+145	+ 380 (26 d)	+1265	+4·2
M 198	HF	16	+180		+ 560	+2·1
	FR	16	+195		+ 820	+2·3
	S:a	32	+375	+ 330 (31 d)	+1380	+4·4
M 203	HF	8	+ 20		+ 115	−0·2
	FR	12	+ 20		+ 165	−0·2
	S:a	20	+ 40	+ 30 (13 d)	+ 280	−0·4
M 209	HF	12	+ 20		+ 170	−0·4
	FR	20	+ 50		+ 580	+0·5
	S:a	32	+ 70	+ 90 (32 d)	+ 750	+0·1
M 210	HF	8	+ 20		+ 460	+2·4
	FR	24	+ 45		+ 825	+2·9
	S:a	32	+ 65	+ 90 (28 d)	+1285	+5·3
M 211	HF	12	+ 35		+ 160	+0·2
	FR	20	+ 80		+ 480	+1·6
	S:a	32	+115	Contaminated	+ 640	+1·8
cM 216	HF	12	+ 35		+ 335	−0·6
	FR	16	+105		+ 665	+2·2
	S:a	28	+140	Contaminated	+1000	+1·6

Table III *Nitrogen and sodium cumulative balances (N_{cum}, Na_{cum}), changes in total body potassium (ΔKe), and body weight (ΔBW) in 13 patients with ileal disease on a 100-g fat diet (HF), 40-g fat diet (FR) or a 40-g fat diet with added cholestyramine (FR+C)*

cal nitrogen balance expresses dermal nitrogen losses (Isaksson and Sjögren, 1967), intracellular deficits of potassium, and/or an extracellular deficit of protein.

SODIUM BALANCE

A surprisingly high sodium retention was found in many patients (table III). These figures cannot be explained by changes in the dermal loss. The high sodium retention found in some patients does not correspond to changes in extracellular water expressed by body weight changes. However, in eight patients with low Na/S (<140 m-equiv/l) a mean increase of 3 m-equiv/l occurred.

CALCIUM AND PHOSPHORUS BALANCE

The duration of the calcium and phosphorus balance studies was found to be too short for evaluation according to our criteria (Isaksson and Sjögren, 1967). The faecal calcium excretion in all patients was high and approached the intake. Urinary calcium was low in most patients, below 50 mg/day in seven patients on the high-fat diet and in five on the fat-reduced diet.

SIGNIFICANCE OF A FUNCTIONING GALLBLADDER

The six patients with a functioning gallbladder (and without gallstones) showed a better clinical improvement on the fat-reduced diet than those who were cholecystectomized and/or showing a non-functioning gallbladder. The body weight increased in the former patients by an average of 2·7 kg compared with 0·6 kg in the other patients. The number of bowel evacuations, the amount of faecal water (fig 1), and faecal sodium (fig 2) on the fat-reduced diet were less in patients with a functioning gallbladder than in patients without. These differences were pronounced even if the colectomized patient M 191 was excluded.

It should be noted that the two patients who needed cholestyramine had a non-functoning gallbladder.

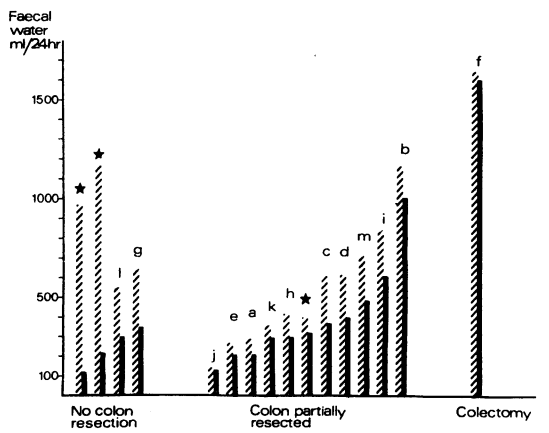

Fig 4 *Faecal water volumes on different dietary fat intakes in relation to colon resections performed in 16 patients with ileal disease. The letters (see table I) refer to patients in this study and the stars to patients with Crohn's disease in a pilot study (Andersson, 1973). Hatched columns, high-fat diet; black columns, low-fat diet.*

THE ROLE OF THE COLON AND THE ILEOCAECAL SPHINCTER

On the high-fat diet, there was no correlation between faecal water volumes and the length of the colon resected (fig 4). The introduction of the fat-reduced diet caused the most obvious decrease in the faecal output of water in patients with an intact colon (and remaining ileocaecal valve).

Discussion

The decrease in the daily number of stools which occurred in most patients shortly after the introduction of a low-fat diet was gratifying and often impressive. The passage of solid faeces in 12 of the present 13 patients was indeed encouraging to these subjects who had suffered from continuous diarrhoea for many years.

As expected, the decrease in the faecal volume corresponded to a decrease in the daily faecal excretion of water and electrolytes. The correlation between faecal water and the faecal excretion of sodium and potassium shown in fig 3 has previously been demonstrated in diarrhoea of a different aetiology (Fordtran and Dietschy, 1966).

A normal colon has a great capacity to absorb sodium and water (Levitan, Fordtran, Burrows, and Ingelfinger, 1962). Strong evidence shows that the bile salts play a role in the pathogenesis of diarrhoea in diseases of the ileum. Malabsorption of these acids in the distal part of the ileum permits the passage of bile salts to the colon, where chenodeoxycolic acid is probably the offending factor in the diarrhoea (Mitchell and Eastwood, 1972; Mitchell, Findlay, Prescott, Eastwood, and Horn, 1973). It is conceivable, therefore, that the favourable effect of the fat-reduced diet could—at least in part—be explained by a decreased exposure of the colonic mucosa to bile acids. Thus, the secretion of bile acids can be expected to decrease when the intake of fat is reduced as shown in primates (Small, Dowling, and Redinger, 1972). The finding that the most significant clinical effect occurred in patients

with a normal gallbladder function may also be explained by the fact that a larger part of the bile salt pool remains in the gallbladder when the patient is on a fat-reduced diet.

Many of our patients had been subjected to large bowel resections or suffered from extensive intestinal changes, which were followed by marked steatorrhoea. The decrease in steatorrhoea explains why the decreased fat intake as faecal fat, expressed as a fraction of the dietary fat, did not change. It is not clear whether the disappearance of the diarrhoea was caused by the low fat intake as such limiting the amount of fatty acids in the colon, or whether it was due to a decreased secretion of bile acids. Studies of the bile acid metabolism in the present patients will be reported elsewhere.

Cummings, James, and Wiggins (1973) have claimed that the extent of the colonic resection is correlated with faecal weight in patients subjected to ileal resection. In the present patients, we were unable to demonstrate such a relationship when the fat intake was high. On the low-fat diet, however, the data can be interpreted as showing a smaller effect of the diet on the faecal volume in patients with the most extensive resections of the colon (fig 4). Thus, the absorptive capacity of the colon might be a limiting factor in the reduction of the water and electrolyte excretion on the low-fat diet.

Although the present patients were often underweight and showed other signs of malnutrition they did not generally show an abnormality low cell mass as estimated from the total body potassium (table I). In fact, the average body potassium was not significantly different from the normal values given by Moore, Olesen, McMurrey, Parker, Ball, and Boyden (1963) with respect to sex, age, and body weight. All except one patient, however, went into a positive nitrogen balance even on the high-fat diet and experienced subjective improvement and some decrease in the incidence of diarrhoea. It must be emphasized that the amount of fat in the high-fat diet was considerably smaller than that spontaneously chosen by the patients. A few of the patients also showed low plasma albumin levels and some of them had clinically demonstrable oedema.

After the introduction of the fat-reduced diet, the nitrogen balance became more positive in most cases, and cannot be explained only by the concomitant increase in the protein intake. This conclusion is supported by the fact that some patients showed a positive nitrogen balance on an unchanged protein intake. In this connexion, it should also be noted that probably most patients were at least periodically in a negative caloric balance before the study. This was evidenced by the fact that a weight gain was often observed on a caloric intake much lower than that taken at home. The weight increase was usually moderate, but it should be noted that the patients were not fed *ad libitum* but were under strict metabolic ward conditions. The degree to which maldigestion and malabsorption of protein in the gastrointestinal tract occurred in our patients is not known. Whether a reduction in the fat intake can improve the efficiency of protein absorption or, perhaps, reduce the abnormal secretion of protein into the intestinal lumen remains to be elucidated.

From a therapeutic point of view, it is important to note that the condition of our patients improved markedly on a daily intake of 40 g of fat. Our experience from the follow up of the present patients shows that such a diet is feasible, as it is palatable and can be arranged to suit the individual patient's need for calories and protein. Hofmann (1972) recommended a drastic reduction in dietary fat to less than 5% of total calories together with the oral administration of medium-chain triglycerides as a supplement. Several other authors have reported on the successful use of medium-chain triglycerides in small bowel disease including Crohn's disease (Zurier, Campbell, Hashim, and Van Itallie, 1966; Winawer, Broitman, Wolochow, Osborne, and Zamcheck, 1966; Greenberger, Ruppert, and Tzagournis, 1967; French, 1968; Pinter, Hyman, and Bolanos, 1969; Sickinger, 1969; Skála, Horáčková, Krondl, Vulterinová, and Šťastná, 1969; Fiasse, Kestens, de Raeymaeker, Huaux, and de Deuxchaisnes, 1970; Hofmann and Poley, 1972).

Few systematic studies of the effect of a more moderate restriction in the dietary fat have been published. Booth *et al* (1964) found a marked decrease in the number of bowel movements in four patients with extensive small bowel disease. Our experience shows that such a diet gives favourable results and that the addition of medium-chain triglycerides is not necessary.

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