SMALL BOWEL LENGTH AND PARAMETERS RELATED TO OBESITY AND WEIGHT LOSS FOLLOWING JEJUNIEAL BYPASS

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An interest in the surgical treatment for morbid obesity has persisted for 20 years. Approximately 15,000 to 40,000 jejunoileal bypass procedures have been performed in the United States during this period. The high rate of complications related to the procedure, however, now indicate that it should be reserved for life-threatening situations.[1] Our prospective study to evaluate the procedure also provided information on parameters which may contribute to the weight loss following jejunoileal bypass, and those which are associated with obestiy. This report presents our findings.

MATERIALS AND METHODS

Patients. Patient selection for inclusion into the study required that they weighed at lease 125 pounds greater than their ideal weight as determined by the Metropolitan Life Insurance Statistical Tables.[2] A complete history, a physical and psychiatric examination, and extensive metabolic studies were performed prior to operation. Patients with serious medical or psychiatric conditions were excluded; and 101 patients were accepted into the study and all patients gave their informed consent.

The physical characteristics of our patients are given in Table 1. The mean age of these patients was 32.5 years + 8.4 (SD). Mean height was 165 + 11 (SD) and initial weight was 136 + 31 (SD). The percent of initial weight above the ideal weight or the fractional ideal weight was determined, and the mean value was 122 + 36% above the ideal weight.

Ninety-eight patients had end-to-end jejunoileal bypass and three patients had end-to-side anastomosis. Eighty-four patients had jejunoileal segments measuring 35 cm and 10 cm respectively. The excluded ileal segment was anastomosed end-to-side to the caecum in most patients.

All patients were seen on an out-patient basis after the operation at monthly intervals for three months, then at two-month intervals until one year, and at three-month intervals for the duration of the study. Patients were seen more often in the office when clinically indicated. More than 20 percent of the patients developed complications which necessitated reversal of the jejunoileal bypass and were deleted from the study.

Parameters.

The inter-operative small bowel length was determined along the antimesenteric border from the ileocecal valve to the ligament of Treitz using an umbilical tape. The initial weight was determined at the pre-operative examination. A patient's age was recorded to the nearest year at the time of operation. Daily bowel activity was recorded by interview at 6, 12, 18, and 24 months following jejunoileal bypass.

Statistical Methods. Correlation coefficients were determined for initial weight, bowel activity, age, and small bowel length compared to the percent of ideal weight at various times following jejunoileal bypass. Small bowel length has also been compared to age, sex, race, initial weight, family history of obesity, fractional ideal weight, height, and onset of obesity with chi-square analysis.

RESULTS

Parameters of physical characteristics were related to small bowel length (Table 2). Heavier patients had a statistically significant (P 0.05) increase in small bowel length. Patients who had a history of childhood obesity had a significantly greater small bowel length as compared to patients who developed obesity during adulthood. There was no significant relationship between small bowel length and the age, sex, race, family history of obesity, a patient's height and the fractional ideal weight.

Correlations between initial weight, bowel activity, age, and length of small bowell to the percent of ideal weight were calculated (Table 3). A significant correlation occurred with patient's initial weight and the percent of ideal weight at six months. There was no correlation when bowel activity, age or small bowel

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length was related to the percent of ideal weight at these time intervals.

DISCUSSION

Small bowel length has been determined during jejunoileal bypass. Our study confirms the report of Backman and Hallbert that subjects with onset of obesity after puberty have a longer small intestine.[3] Thus, excessive food intake may be because of a long small intestine and may also be related to the development of obesity in these individuals. It has been demonstrated that excessive food intake by animals is associated with heavier intestines.

Juhl et. al have demonstrated that the length of the remaining functional small bowel is one of the major factors to determine weight loss after jejunoileal bypass.[4] When small bowel length is reduced and becomes a measure of the absorptive capacity, the length of the remaining small bowel should determine wieght loss. Our study indicates that a 35 cm/10 cm jejunoileal segment produces an initial rapid weight loss, and in time, weight in most patients stabilizes above the ideal weight.

The kinetics of weight loss after intestinal bypass may also be related to initial small bowel length.[5] By multiple regression analysis a predictive equation was derived. The percent of ideal weight loss at one year was based on constants and variables of age, bowel length, admission weight, sex and the number of bowel movements per day. In our study we determined the degree of weight loss by the change in percent of ideal weight. There was no indication that the factors of initial weight bowel activity, age, or length of small bowel were significantly related to weight loss after 6 months. This, therefore, suggests that many other parameters must influence the eventual outcome of jejunoileal bypass. Other factors which also affect the rate of weight loss are: 1) the rate of intestinal transit, 2) changes in pancreatic or biliary secretions and absorptive capacity, 3) the intestinal reserve following jejunoileal bypass. A decrease in transit time of intestinal contents could allow for greater contact with the mucosal absorptive area to improve absorption. An increase in transit would promote malabsorption. The effect of jejunoileal bypass on transit time is not known.

Two factors determine the absorptive capacity of the small bowel. The first is the relationship of intestinal motility and the rate of absorption. The second is the location of specific carrier proteins in the regional small bowel. If transit or motility increases substances which may normally be absorbed in the proximal small bowel may be propelled to the distal small bowel for absorption. Our previous studies indicate that both the ileum and jejunum adapt following small bowel bypass.[6] Specific enzymes in these regions increase within one year after surgery. The role of pancreatic enzymes and bile salts in micelle formation is also known to be important in aiding fat absorption in these patients and thus would affect weight loss. Bile salt pool sizes have become significantly decreased in time following surgery.[7]

The second factor which determines the location of absorption in the small bowel is the location of specific carrier proteins. Vitamin B12 and conjugated bile salts are unique in that they are absorbed in the distal small bowel. The significant decrease in bile salt pool size suggests that the adaptive response of the remaining ileum is not sufficient in all patients to maintain adequate pool size.

The functional reserve of the small bowel is probably different for various substances. Water soluble vitamins seem to be absorbed readily and thus the small bowel has large capacity for these molecules. The absorption of fat, however, requires micelle formation and the action of pancreatic secretions for adequate digestion and absorption. The functional reserve of these molecules in the small bowel is thus probably smaller or less than water soluble substances. These physiological parameters thus must be important factors which influence weight loss. The physical characteristics of patients, however, may not be related to weight loss.

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TABLE 1

PHYSICAL CHARACTERISTICS OF PATIENTS

AGE		INITIAL WEIGHT (KGS)		HEIGHT CM		FRACTIONAL IDEAL WEIGHT* (%)	
RANGE	NO.	RANGE	NO.	RANGE	NO	RANGE	NO.
16-20	3	< 90	2	< 150	3	51-100	25
21-30	45	90-135	55	150-159	10	101-150	45
31-40	35	136-180	38	160-169	56	151-200	21
41-50	15	181-225	3	170-179	28		
51-60	3	226-270	1	180-189	4		
		271-315	1				
$32.5 \pm 8.4^{+}$		$136 \pm 31^{+}$		$165 \pm 11^{+}$		$122 \pm 36^{+}$	

*FRACTIONAL IDEAL WEIGHT =

$$\left[\left(\frac{\text{INITIAL WEIGHT}}{\text{IDEAL WEIGHT}}\right)(100)\right] - 100$$

+MEAN AND STANDARD DEVIATION

TABLE 2

DISTRIBUTION OF PATIENTS BY SMALL BOWEL LENGTH AND PHYSICAL CHARACTERISTICS

SMALL BOWEL LENGTH (CM)		AGE (YEARS)		SEX		RACE		HEIGHT (CM)		INITIAL+ WEIGHED (KG)		FRACTIONAL* IDEAL WEIGHT %		ONSET OF OBESITY+		FAMILY HISTORY OF OBESITY	
		16-30	31-53	M	F	W	B	150-165	>165	87-136	>136	<100	101-147	CHILDHOOD	ADULTHOOD	YES	NO
	528	14	19	3	30	27	6	21	12	23	10	9	16	22	11	16	13
528	610	17	16	4	29	25	7	19	14	22	11	9	16	27	3	10	15
611	922	17	17	7	27	23	10	14	19	14	20	7	13	29	5	17	12
	Nc	48	52	14	86	75	23	54	45	59	41	25	45	78	19	43	40

*Fractional Ideal Weight was determined by $\left[\left(\frac{\text{Initial Weight}}{\text{Ideal Weight}}\right)(100)\right] - 100$

+Statistically significant ($p < 0.05$)

NR is the maximum sum of patients in rows.

Nc is the sum of patients in columns.

TABLE 3

CORRELATIONS OF INITIAL WEIGHT, BOWEL ACTIVITY, AGE AND LENGTH OF SMALL BOWEL TO PERCENT OF IDEAL WEIGHT AT VARIOUS TIMES AFTER OPERATION

		TIME (months)			
		6 ± 1	12 ± 1	18 ± 1	24 ± 1
INITIAL WEIGHT (lbs)	r	0.344	0.159	0.007	−0.186
	p-value	<0.05	>0.30	>0.95	>0.45
	N	35	36	26	17
BOWEL ACTIVITY (FREQUENCY/DAY)	r	−0.165	−0.182	−0.011	0.298
	p-value	>0.35	>0.25	>0.95	>0.30
	N	31	36	26	13
AGE (yr.)	r	−0.065	0.139	0.250	−0.193
	p-value	>0.70	>0.40	>0.20	>0.45
	N	35	37	26	17
SMALL BOWEL LENGTH (cm)	r	0.207	−0.297	−0.033	−0.291
	p-value	>0.20	>0.05	>0.87	>0.25
	N	35	37	26	17

r is the Pearson Co-relation Coefficient.

N is the number of patients subjected to statistical assay