Pancreatic Secretion in Response to Jejunal Feeding of Elemental Diet

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The instillation of elemental diet into the proximal jejunum of dogs results in a brisk pancreatic secretory response, but the fluid is watery and "enzyme-poor." The administration of the caloric equivalent in a standard blenderized ward diet induces pancreatic enzyme secretion. Although elemental diet does not "rest" the pancreas, the failure of these preparations to stimulate pancreatic enzyme secretion gives them a theoretical advantage as a nutritional source in the convalescent phase of acute pancreatitis.

PATIENTS CONVALESCING from severe pancreatitis often present problems with prolonged gastric retention and consequent nutritional deprivation. The "triple-tube" technique of managing these complications, with gastrostomy, jejunostomy, and cholecystostomy is often employed when severe pancreatitis is encountered at laparotomy.[3] The method provides for long term gastric decompression, without a levine tube, and a safe route for nutritional support.

The instillation of food into the proximal jejunum has been regarded by many clinicians as being relatively free of hazard, insofar as pancreatic stimulation and the reactivation of a smouldering pancreatitis is concerned. It is known however, that when jejunum is exposed to various nutrients, pancreatic secretion results.[2]

It has recently been claimed that elemental diets do not elicit pancreatic secretion, and that these formulas should be used in the nutritional management of pancreatitis. No data recording the volume and type of pancreatic secretion resulting from elemental diet feeding, either orally or by jejunostomy, are currently available.

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A study was therefore designed in dogs to determine the effect on pancreatic secretion of elemental and blenderized diets, infused through a jejunostomy.

Methods

Four adult dogs were prepared with Thomas cannulae in the stomach, duodenum and proximal jejunum. The main pancreatic duct was cannulated and the catheter allowed to lie in the duodenum. When the animals were fully recovered from the laparotomy (usually three weeks) the experiments were commenced.

In each animal, a stable 50% of maximum pancreatic secretory response was first obtained by infusing secretin 3 μ/Kg and pancreozymin CCK 6 μ/Kg. These 50% maximal doses were ascertained by constructing a dose response curve for each animal prior to testing.

The pancreatic secretory response to the jejunal feeding of elemental diet (Table 1) and the nutritional equivalent of blenderized ward diet (Table 2) was then measured. Elemental diet has been extensively tested in human volunteers and no toxic effect has been shown by a spectrum of hepatic, renal, and haematological determinations. Two experiments with elemental diet infusion, and two with blenderized diet were carried out on each animal. (Eight elemental diet infusions and eight blenderized diet infusions).

In each experiment, the duodenostomy and gastric cannulae were opened. The stomach was allowed to drain freely. The pancreatic cannula was removed from

TABLE 1. *Elemental Diet Composition*

	Grams/ 1000 Cal		Caloric Contribution/ 1000 Cal	
Protein Equivalent	24.07		96	
Protein Hydrolysate Powder		22.94		92
Added Amino Acids		1.13		4
Fat	34.29		304	
Soy Oil (Lightly Hydrogenated)		26.63		240
MCT (75% C_8–25% C_{10})		6.66		55
Lecithin		1.00		9
Carbohydrate	149.93		600	
Corn Syrup Solids		63.20		253
Sucrose		77.34		309
Tapioca Starch		9.39		38
Total	233		1000	
pH 5.80				

the duodenum and a basal secretory rate determined over one hour. The plateau of 50% maximal secretion was first established. Jejunal feeding with either elemental or blenderized diet was then given by infusion through the jejunostomy cannula. Test infusions were made through a catheter inserted well down the jejunum in order to avoid reflux into the duodenum. No reflux was noted at the duodenal cannula. Elemental diet feedings were prepared with 50 gm of diet in 200 cc of water, while the blenderized ward diet consisted of a low residue preparation with the same caloric value (1 calorie/cc). The diet infusion was completed over one hour. Fifteen-minute collections of pancreatic secretion throughout the basal, infusion and post infusion period were analysed for HCO_3 and protein (enzyme) concentration.

Results

Jejunostomy feeding with elemental or blenderized diets did not "rest" the pancreas, and clearly had no inhibitory effect. Elemental diet in the jejunum increased the volume and HCO_3 content of pancreatic secretion (p .001 and .05) above the 50% of maximum plateau. (Figs. 1 and 2 and Table 3).

When compared to blenderized diets, elemental diet infusion resulted in a greater volume (p .007) and increased HCO_3 content of pancreatic secretion. The protein (enzyme) concentration in pancreatic juice fell when elemental diet was infused (p .0001).

Blenderized diets, however, increased the protein content of pancreatic juice above the plateau (p .05). The opposite effects of blenderized and elemental diet on pancreatic enzyme secretion is shown in Fig. 3.

The results are summarized in Table 3, and the contrasting effects of elemental and a blenderized ward diet on volume, protein and HCO_3 concentration are shown in Figs. 1–3.

Discussion

The infusion of nutrients through a feeding jejunostomy is not without risk in patients with subsiding pancreatitis. It has been recognized for many years that pancreatic secretion is stimulated by the presence of various

TABLE 2. *Blenderized Tube Feeding*

	Grams	Protein	Fat	Carbohydrate
Fruit: Unsweetened Orange Juice	50	0.5	0	5.5
Vit. Apple Juice	150	Tr	0	18.0
Sweetened, strained	200	0.8	0.9	32.2
Egg: Pasteurized whole	150	19.5	18.0	0
Cereal: Pre-cooked infant, dry, "mixed"	50	7.5	1.5	34.7
Corn Syrup	40	0	0	30.0
Bread: Enriched white, crustless	100	8.0	4.0	52.0
Margarine: Fortified	20	0	16.0	0
Cream 9%	120	4.0	11.0	5.5
Whole Milk	720	24.0	24.0	36.0
Skim Milk Powder	48	17.2	0.4	24.8
Lean Meat or Poultry: Strained	240	30.7	19.4	0.5
Vegetables: "All" vegetables, strained	100	1.7	0.5	8.5
Non-starchy vegetables, etc.	200	2.8	0.8	12.6
Potatoes: Dehydrated flakes, dry	50	3.6	0.3	42.0
Vegetable Oil	30	0	30.0	0
Prepared Dessert: Salt free custard	120	6.0	6.0	14.0
Water to bring volume (ml.) to:	3,000			
Totals		126.3	132.8	316.3
Calories:			2,965	
pH			6.25	

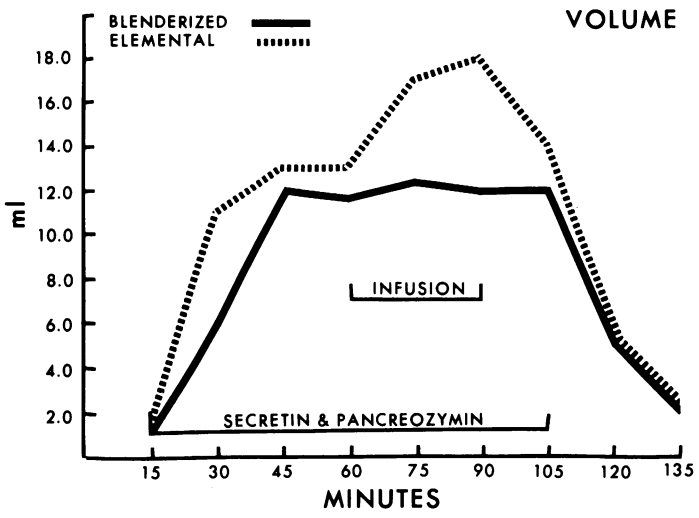

FIG. 1.

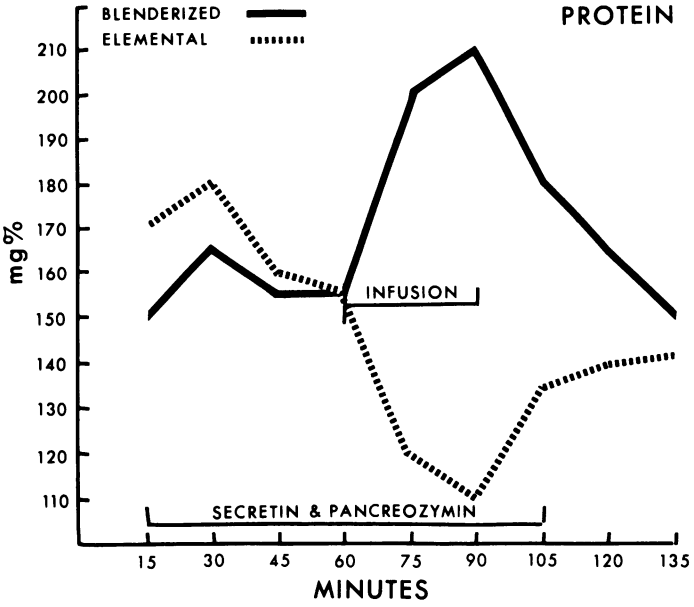

FIG. 3.

FIGS. 1–3. The effect of blenderized diet and elemental diet on the volume (Fig. 1), HCO_3 (Fig. 2) and protein concentration (Fig. 3) is compared in the same animal tested on subsequent days. Blenderized diet induces a prompt increase in protein (enzyme) concentration of the pancreatic juice, but no change in HCO_3 concentration or volume/15 minute interval. Elemental diet however, causes a further increase in volume, and a sharp drop in enzyme concentration.

food products in isolated jejunal segments. Although a feeding jejunostomy provides a convenient means of supplying calories and protein in patients with gastric retention, it is sometimes forgotten that a mechanism for pancreatic secretion is still intact, even though the gastroduodenal mucosa is by-passed.

Theoretically, intravenous feeding would not stimulate pancreatic secretion, although there is no data available as yet to confirm this. Complications associated with placement of catheters, and the relatively limited calorie and protein intakes possible, make the intravenous route less desirable.

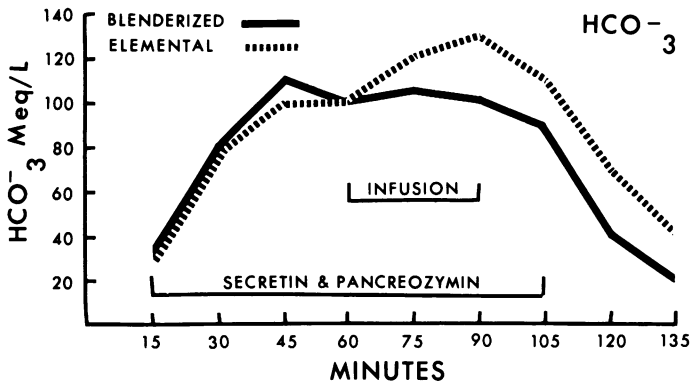

FIG. 2.

Clearly, a jejunal feeding which supplied a high calorie, high protein intake without stimulating pancreatic secretion would be highly desirable, and such claims have been made for elemental diets (Flexical). Brown reported that dogs fed the elemental diet orally for ten days had elevated trypsinogen levels in pancreatic tissue, and that secretory granules remained in a resting state.[1] This group further reported on patients managed with the elemental diet and made frequent reference to the "pancreatic rest" induced by elemental diet feeding.[4]

Direct measurement of pancreatic secretion does not support this concept. Instilling elemental diet into the jejunum induces a brisk pancreatic response. It may be important however, that the elemental diet appears to induce a secretin-like pancreatic response (high volume, HCO_3 rich, enzyme poor). The caloric equivalent in a blenderized diet results in pancreatic enzyme secretion (panocreozymin effect). These findings support the histochemical and electromicroscopic data of Brown, which appears to demonstrate a resting pancreas, from the standopint of enzyme secretion.

Whether the patient with a subsiding pancreatitis is fed orally, or by jejunostomy feeding, there would appear to be a clear theoretical advantage in the use of an elemental diet. The best route for administration of the diet is by feeding jejunostomy, and surgeons finding severe pancreatitis at laparotomy, or performing major pancreaticoduodenal surgery, should anticipate gastroduodenal obstruction, ileus, fistulas, pseudocysts and abscesses and provide a jejunostomy for nutritional support.

TABLE 3. *Pancreatic Secretion in Response to Elemental and Blenderized Diet*

	Mean Basal Output/15			Mean Plateau Output/15			Mean Feeding Output/15			Mean Post Feeding Output/15		
	Vol ml	HCO_3 MEq/L	Protein mg%	Vol.	HCO_3	Protein	Vol.	HCO_3	Protein	Vol.	HCO_3	Protein
Elemental Diet												
Dog #101	1.2	30	170	9.8	95	133	12.2	130.0	113.5	3.5	47.5	149.5
				12.3	100	182.5	18.0	139.0	139.0			
Dog #102	1.6	47	156	8.4	125	160.0	15.3	110	109	3.5	50	156.0
				13.9	100	157.5	17.5	122.5	115			
Dog #103	1.2	45	132.5	9.1	98	129	15.2	116.0	98.0	3.25	57.5	142.5
				12.6	129	129	17.2	120.0	97.0			
Dog #104	2.0	42.5	125	10.0	90	130	15	120.0	100	3.0	40	137
Mean	1.5	41.1	146.0	10.8	110.5	145.5	15.9	122.0	108.7	3.42	45.0	146.2
Blenderized Diet												
Dog #101	1.1	37	147.5	11.9	105	155	12.1	100.6	205.0	3.5	45	157.75
				9.5	99	150	10.1	85.0	207.5			
Dog #102	1.6	58	150	10.9	130	137.5	11.2	138	188.7	3.5	60	153
				9.9	115	136.5	9.8	122	188.0			
Dog #103	1.5	49	105	8.4	100	120	9.4	114	180.9	3.0	55	119.75
				8.1	103.3	117.5	9.4	114	170.0			
Dog #104	1.7	40	130	10	100	135	11	110	170	3.0	40	135
Mean	1.5	46	133.1	9.7	104.6	136.0	9.0	111.9	188.4	3.22	49.0	114.0
Elemental Diet	1.5	41.1	146.0	10.8	110.5	145.5	15.9	122	108.7	3.42	45.0	146.2
Blenderized Diet	1.5	46	133.1	9.7	104.6	136.0	9.0	111.9	188.4	3.22	49.0	114.0
							P = .007		P = .0001			

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