Rational Use of Elemental and Nonelemental Diets in Hospitalized Patients

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Study A included 30 patients who received immediate postoperative enteral feeding with a nonelemental diet. The nonelemental diet was well tolerated. Study patients rapidly achieved nitrogen equilibrium and had a cumulative nitrogen balance of −11.1 g versus −46.7 g for the control group. In part B, 16 patients with varying degrees of bowel dysfunction received elemental and nonelemental diets in a crossover design. Patients with moderate small bowel impairment tolerated nonelemental better than the elemental diets. In those patients with more severe bowel impairment, the elemental diet was better tolerated. Nitrogen balance for both types of diet was similar in both groups of patients. It is concluded that nonelemental diets are better tolerated in most patients with moderate degrees of small bowel abnormality. In patients with severe bowel abnormality, elemental diets may be better tolerated, but nonelemental diets should still be the initial formula.

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THE IMPORTANCE OF ADEQUATE nutrition in recovery from sickness and healing of wounds has been recognized for many years. In the 1920s, the first attempts at tube feeding were by means of administering "blenderized" foods through large bore nasogastric tubes. However, no concerted effort was made to refine the formulas or techniques of enteral feeding until the last 10–15 years. Meanwhile, from the late 1930s until 1969, there were sporadic reports of successful attempts at intravenous feeding. However, following Dudrick's report, interest in intravenous feeding and the modifications and refinements of this route of feeding have received major attention.

Winitz in 1965[16] reported on the feasibility of supporting life with an elemental diet of protein hydrolysates, small amounts of fat and carbohydrates. This was developed for the NASA Space Program as a low residue diet. In 1969, Stevens and Randall first reported the use of an elemental diet in various catabolic states and patients with short bowel.[9,10,13,14] In parallel with this, Gurd et al. developed a similar elemental diet.[1] This work was continued by Bounous, et al., who demonstrated the benefits and effectiveness of this elemental diet for animal models receiving chemotherapeutic agents radiotherapy, and preshock treatment of the gastrointestinal tract when it appeared to lessen some of the effects of hyotension.[1,2] All of this early work was done with elemental diets[4,11] consisting of protein hydrolysates or crystalline amino acids as protein source with dextrose as carbohydrate calorie source and a small amount of fat usually as medium chain triglycerides. Hence many physicians subsequently came to believe that enteral feeding, particularly in situations requiring tubes for access to the gastrointestinal tract, necessitated elemental as opposed to nonelemental diets. The available nonelemental diets were used primarily as nutritional supplements.

Digestion of nutrients occurs principally at the brush border of the small intestine. There are separate pathways for the absorption of di- and tripeptides which may in fact be more efficient and less energy consuming than those for pure amino acids.[7] It is therefore possible that patients with impaired small bowel function may in fact be capable of digesting and absorbing nonelemental diets. If this is tenable, there are two major advantages to the use of nonelemental diets.[4,11] First, they have a low osmolarity. Therefore, patients adapt to them rapidly without any of the side effects associated with elemental diets. Second, they are considerably cheaper. The main advantages of elemental diets are that they are free of bulk and lactose. Allegedly, they are also absorbed more easily with less gastrointestinal secretion. On the other hand, the predigested nature of the elemental diets results in a high osmolarity. In the past ten years, several low residue, lactose-free nonelemental diets have been developed

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which, similar to elemental diets, can be infused through very small tubes. The purpose of this study was to examine whether these nonelemental liquid diets possessed any advantages or disadvantages compared to commonly used elemental diets.

Methods A

In part A of the study, 30 patients were studied postoperatively. The study group consisted of 20 patients who received a nonelemental diet. Ten control patients received crystalloid solutions intrajejunally. All study patients had jejunostomies performed at the time of abdominal surgery, either using a #8 French feeding tube or a #10 catheter jejunostomy.[3,12] The jejunostomy was inserted six inches distal to the ligament of Treitz. Once the patient was stabilized in the recovery room, he received all fluid and electrolyte requirements by the jejunostomy tube. At 8 am on the first postoperative day, three-quarter strength Isocal® was started at 75 ml/hr. This was increased in rate and volume so that 36 hours later the patient was receiving 125 ml/hr of full strength Isocal. Complications such as nausea, vomiting, diarrhea or cramps were treated initially by slowing the rate of infusion. If this failed to control the symptoms, patients then received the appropriate antidiarrheal or antinauseant agent. Once the symptoms abated, the rate was then once again increased. The control patients received all fluid and electrolyte requirements jejunally as crystalloid solutions. They were started on oral intake when judged ready by their attending surgeon and normally progressed from fluids to diet as tolerated by the fifth day. Patients in both groups were weighed daily. Routine blood biochemistries were done preoperatively and every other day. All urine and gastric aspirates were collected in acidified containers and pooled every 24 hours. Nitrogen content was measured by the micro-Kjeldhal technique. Statistical comparison between the two groups was performed using the Student's t-test for unpaired variables.

Methods B

Study B dealt with 16 patients hospitalized with a variety of medical and surgical problems. The degree of functional impairment of the small bowel was classified as mild to moderate or severe. Examples of the former included patients with malnutrition and long periods of reduced oral intake or those receiving chemotherapy or radiotherapy. Examples of the latter included patients with radiation enteritis or short-bowel syndrome. The purpose of the study was to show whether nonelemental diets might suffice in many situations, where traditionally elemental formulas were usually administered.

Patients were given two liquid diets, Vivonex-HN® (elemental) and Precision-HN® (nonelemental). The elemental diet had synthetic amino acids as the protein source, 1% fat, glucose as the calorie source with an osmolarity of 850. The nonelemental diet had egg albumin as the protein source, 1% fat and glucose as the calorie source with an osmolarity of 550. The diets were infused by pump through a #8 French nasogastric tube,[6,8] gastrostomy or jejunostomy[3] in a crossover design. Patients were divided into two groups determined by their odd or even hospital numbers. Group I received Vivonex-HN first until adapted to full strength solution at 3000 cal/day. They received the product for one week and then were changed to Precision-HN full strength 3000 cal/day for a further week. An adaptation period for Precision-HN was not needed due to its low osmolarity. Group II received Precision-HN for one week preceeded by a short adaptation period until 3000 cal/day of full strength solution was tolerated. Adaptation implied that the patient was receiving and tolerating 3000 cal/day of full strength formula without nausea, vomiting, diarrhea or cramps; and for patients with short-bowel syndrome, with not more than two liquid bowel movements per day.

While on the study, patients were allowed only low calorie fluids by mouth. Bulk-forming agents, laxatives or constipating agents were not permitted. The parameters monitored daily included weight, pain, bloating, nausea and vomiting, diarrhea as well as skin testing (with PPD, candida, varidase and mumps) and appropriate hematologic and biochemical tests. Daily 24-hour urines and stool were collected in acidified 24-hour containers, frozen and later analyzed for nitrogen content using micro-Kjeldahl technique. Carmine red was used as a stool marker.

Results A

There were no complications attributable to the feeding tubes in any of the patients. Six study patients developed episodes of nausea, vomiting, diarrhea or cramps that necessitated slowing of the infusion rate, giving an incidence of 0.7 complications per patient. The study patients achieved nitrogen equilibrium by the third day. The mean cumulative nitrogen deficit by the end of the fourth postoperative day for the study patients was -11.1 ± 1.9 g. Control patients had considerably less nitrogen intake, as expected. Their mean cumulative nitrogen deficit at the end of the fourth postoperative day was 46.7 ± 7.0 g. Both groups exhibited an increase in nitrogen excretion in the postoperative period, that of the fed group being greater (1.57 g/day) than that of the unfed group (0.67 g/day). Serum albumin levels fell by $0.01 \pm .17$ g/dl during the study period as compared to a fall of $0.18 \pm .17$

g/dl in the unfed controls. Study patients also had less weight loss (study $-2.02 \pm .54$; controls -2.87 ± 0.54 kg). These differences were not statistically significant.

Results B

Of 16 patients studied, complete results were obtained in 12. Problems in collecting stool and/or urine resulted in four partially studied patients. There were no complications attributable to the feeding tube. Adaptation to the nonelemental diet took 20–48 hours compared to 3–6 days with the elemental diet. Crossover from elemental to nonelemental did not require any adaptation but the reverse required 2–3 days. Ten patients with moderately abnormal bowel had no complications with the nonelemental diet but with the elemental diet, diarrhea occurred in nine patients; nausea and vomiting in one patient; cramps in three patients and bloating in all ten patients. Diarrhea disappeared when adaptation was complete but bloating continued throughout the study. In six patients with severely abnormal small bowel, there was one case of diarrhea, one of cramps and two with bloating on elemental diet during the one-week study period. During nonelemental infusion, there were three cases of diarrhea, three cases of cramps, one of bloating and one of nausea. Diarrhea on elemental diet occurred mainly during adaptation, but cramps and bloating persisted during the entire study. During adaptation to nonelemental feeding, one case of diarrhea occurred but cramps persisted off and on during the study.

Nitrogen intake for these patients while on the elemental diet was 14 ± 0.8 (SEM) gm, and 17 ± 1.1 g/day on the nonelemental diet ($p < 0.05$). Nitrogen output on the elemental diet was 10.1 ± 1.1 g/day. Corresponding with nitrogen intake, daily nitrogen output on the nonelemental diet was 12.2 ± 1.1 g. This resulted in a mean daily nitrogen balance of $+4.4 \pm 1.0$ g on the elemental diet, compared to 5.0 ± 1.1 g on the nonelemental diet. The difference is not statistically significant. The average daily fecal nitrogen loss was 1 g. However, one patient with a severe short-bowel syndrome lost 1.8 g per day while on the elemental diet, and 3.6 g per day on the nonelemental diet. The stool frequency on both products was one formed bowel motion every second day, resulting in a daily average wet weight of stool of 75 g.

Body weight remained essentially the same for eight patients, while four patients gained an average of 2 kg during the study period. None of the patients lost weight. Serum chemistry remained stable during the study period. In particular, there was no significant change in serum albumin levels. Cholesterol levels remained essentially unchanged but triglyceride levels rose to a mean of 280 mg/dl from 195 mg/dl. Two of the 16 patients converted three of four skin tests from negative to positive.

Discussion

Enteral feeding was well tolerated by the patients who received early postoperative enteral feeding. Rapid adaptation was achieved; all patients tolerated 125 ml/hr of full strength feeding solution within 36 hours. This meant that the period of negative nitrogen and caloric balance was minimal during the postoperative period. No statistically significant differences were noted in weight change or serum albumin between the study and control groups. No problems occurred attributable to either tube or needle jejunostomy in our patients, apart from the need to occasionally irrigate the tubes which became temporarily occluded.

Nausea and cramps are symptoms often associated with recovery from abdominal surgery. The incidence in the study patients is within the range expected for a group of patients treated by conventional means. The incidence of diarrhea was 5%, considerably less than the 30% incidence reported by Hoover using an elemental diet in the postoperative period.[5] Length of hospital stay and complication rates for the two groups of patients were the same. It is postulated, but as yet unproven, that in a study with a longer period of nutritional support following surgery, differences would become apparent.

Most patients can easily withstand the short period of negative nitrogen balance that follows abdominal surgery. However, in patients with pre-existing malnutrition, those in whom a prolonged period of minimal oral intake is expected or when postoperative complications are anticipated, nutritional support offers potential benefits. It is in these patients that we advocate the use of immediate postoperative nutrition with nonelemental formulas.

In Study B, where elemental and nonelemental diets were compared,[4,15] the nitrogen balance data for each study period was similar ($+4.4 \pm 1.1$ g versus $+5.0 \pm 1.0$ g/day, $p < 0.2$). However, when this group was subdivided into those with moderate and those with more severe small bowel dysfunction, differences could be noted. In the former, adaptation to the nonelemental formula was considerably more rapid than to the elemental (36 hours versus 4 days). Complications were higher with the elemental formula, presumably due to the higher osmolarity. It was interesting yet enigmatic to observe the persistent subjective complaints from patients receiving elemental formula even after adaptation had occurred. In the patients with more severely damaged bowel, differences between the two formulas were less clear. Symptoms attributable to administration were observed in both study groups. There was a higher incidence of complications with the nonelemental diet. Yet, nonelemental formulas were quite well tolerated in many instances despite severely compromised small bowel function. Despite differences in incidence of symptoms, all patients either maintained weight or gained weight.

Stool frequency (one bowel movement every two days), weight (75 g/day) and nitrogen loss (1 g/day) were comparable on both products. Therefore, both diets could be considered of equally low residue. The hematologic and biochemical parameters were not significantly changed. In no patient was there a decrease in the serum albumin level. Slight but insignificant elevation were noted in some. Albumin is a good nutritional indicator but is slow to rise with nutritional repletion. Cholesterol levels were within normal limits but triglycerides were elevated with a mean of 280 (N up to 150) in six patients tested twice a week, presumably as a result of feeding very high amounts of carbohydrates. The significance of this is not clear but may be related to the fact that patients received 90% of their calories as carbohydrate.

The rationale for comparing elemental and nonelemental diets was to show that elemental diets are not required in many situations. This is borne out by our data. Nitrogen balance was essentially similar for both groups. The incidence of complications was higher for the elemental diet in mild to moderate degrees of small bowel damage but greater with the nonelemental diet in patients with more severely compromised bowel. During the study period, all patients appeared to receive adequate nutritional support, regardless of the diet infused. Because nonelemental diets are considerably cheaper than elemental diets, and the end result for both diets in our patients was similar, they would seem to be more effective. We would, therefore, advocate the use of nonelemental diets in all patients in whom enteral nutritional support is required even when there is some degree of small bowel dysfunction. In our patients, this policy was eminently successful with the nonelemental diet but there appeared to be a trend which suggested that, in those very few patients with severely compromised small bowel (*i.e.* extreme short-bowel syndrome or extensive radiation enteritis), there is a role for elemental formulas. Nutritional support, as judged by nitrogen balance was the same for both diets. Therefore, there would be no deleterious effect in attempting to adapt the patient to a nonelemental diet first. Also, to be noted is that even in patients with severe short-bowel syndrome, many complications referrable to high osmolarity occurred. This disadvantage probably outweighs the theoretical advantages of elemental composition in many patients.

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