The Use of ORAL HIGH FAT, HIGH CALORIE EMULSION *for Total Feeding*

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While restricted to a liquid diet, the maintenance or restoration of body weight, a positive nitrogen balance, and an adequate caloric, mineral and vitamin intake have in the past been achieved only with some difficulty. Recent studies[1-4] have indicated that fat emulsions can be readily used as a source of available calories. According to these reports, the desirable features of the emulsions include ease of handling and mixing in liquid preparations, good stability at the usual temperatures of storage, and a relatively high acceptance of the preparation when combined with suitable flavoring agents. This study was undertaken to determine if a high calorie, high fat liquid feeding could be administered to selected patients as the sole source of feeding, and if this would be accompanied by gain in weight, restoration of positive nitrogen balance, and minimal alteration in normal metabolism.

Experimental Methods and Procedures

Six patients with fracture of the mandible and wiring were followed with metabolic studies. All had lost weight prior to the initiation of the study. All received a high calorie liquid feeding, consisting primarily of a 40 per cent emulsion of peanut oil[§] which supplies 4.0 cal. per ml. This was prepared by combining a protein concentrate[**] with the emulsion and adding sodium chloride, iron, and ascorbic acid in order to include the daily requirements of electrolytes, minerals, and vitamins. In the preparation 100 Gm. of the protein concentrate, which also contained many vitamins and minerals, was added to 1000 ml. of the fat emulsion. One hundred mg. of ascorbic acid, 4.0 Gm. of sodium chloride as a normal saline solution, and 85 mg. of iron as ferric ammonium citrate were added, and the preparation mixed in a blender. This was then refrigerated until consumed. Five of the patients consumed the arbitrarily determined amount of 1000 ml. of the fat emulsion and supplements daily in divided feedings, providing 4370 cal. The sixth patient varied his daily intake over the period of study, beginning with a smaller amount of the preparation, consuming the fixed amount of 1000 ml.

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§ Lipomul, Oral (Upjohn), a 40 per cent emulsion of peanut oil, with 10 per cent dextrose, 2 per cent purified soybean phosphatide, and 0.2 per cent synthetic emulsifier (alkylarylpolyether alcohol). One thousand ml. of this emulsion contains 200 mg. sodium, 250 mg. potassium, 140 mg. chloride, 50 mg. calcium, and 600 mg. phosphorus.

** Somagen (Upjohn), 100 Gm. contains 70 Gm. milk protein, 22 Gm. dextrose, 150 mg. sodium, 1.40 Gm. potassium, 1.20 Gm. chloride, 1.40 Gm. calcium, 1.0 Gm. phosphorus, 5 mg. thiamine, 5 mg. riboflavin, 2 mg. pyridoxine, 10 mg. calcium pantothenate, 30 mg. nicotinamide, 2 mg. folic acid, 2 Gm. liver concentrate, and yeast extract from 15 Gm. yeast.

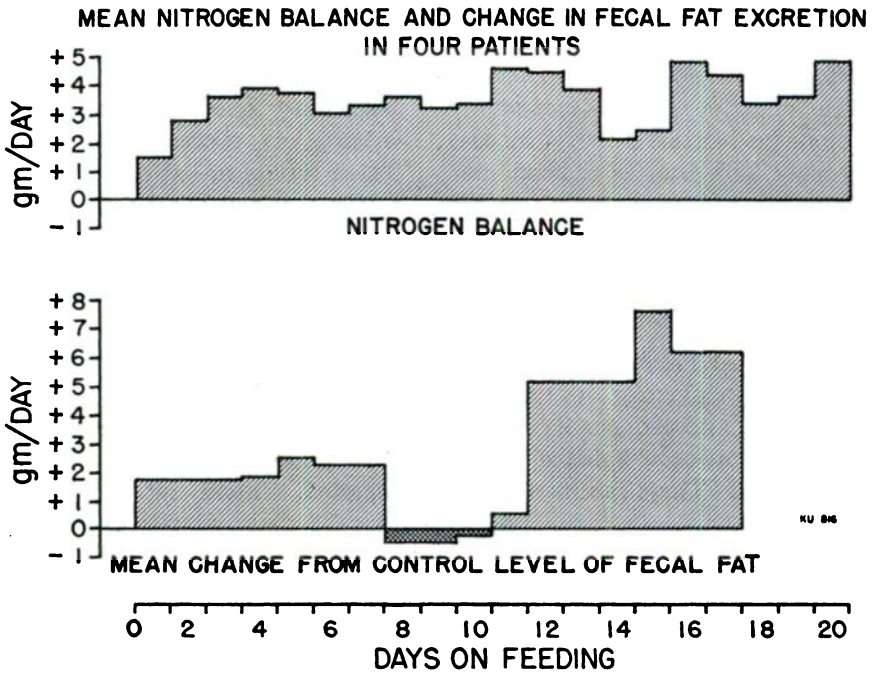

Fig. 1. Mean nitrogen balance and change in fecal fat excretion in four patients.

for seven days, then further increasing his intake.

All patients were weighed daily and control weights were recorded for a period preceding and following the feedings. Each patient reported all changes in bowel habits and subjective changes in appetite, digestive symptoms, and strength. The following determinations were made at the intervals noted: urine volume and nitrogen excretion,[5] daily; urinary ketones[6] and urobilinogen,[7] semi-weekly; fecal nitrogen[5] and fat[8] excretion, 3–5 day collections; blood total and neutral fat,[9] phospholipid,[10] CO_2 content,[11] non-protein nitrogen,[12] fasting blood sugar,[13] weekly; serum total protein[5] and A/G ratio,[14] free and total cholesterol,[15] sodium,[16] potassium,[17] and chloride,[18] weekly; basal metabolic rate and respiratory quotient by collection of expired air with a Douglas bag under basal conditions and analysis in the Haldane apparatus, weekly.

Results

The results obtained with the first five patients studied are summarized in Table I and Figure 1. The results on the sixth patient are presented separately, since he did not consume the fixed daily amount of the emulsion and hence had a variable daily caloric, mineral, and vitamin intake.

All five of the initial patients gained weight while on the fixed intake of 1000 ml. of fat emulsion in a complete feeding. The weight gain ranged from 2.75 to 12.25 lb. in a period of from 12 to 24 days, or an average of 7.6 lb. in 18.8 days. The average daily weight gain per 1000 ml. of fat emulsion was 0.4 lb. All patients noted an increase in strength and four noted an increase in appetite. Two patients developed symptoms of intolerance and were

TABLE I

	Number of patients	5
	Average age	36
Average daily total intake	Carbohydrate, Gm.	122
	Protein, Gm.	70
	Fat, Gm.	400
	Calories	4368
Average number of days		18.8
Average daily intake of emulsion, ml.		1000
Average daily calories from emulsion		4000
Number of patients gaining weight		5
Average weight gain, lb.		7.6
Number of patients losing weight		0
Average weight loss, lb.		0

not suitable for metabolic studies; their results are not included in this report.

While the five subjects were on a fixed intake of 400 Gm. of fat per day the mean daily fecal excretion of fat increased above the control level by only 7.68 Gm. as a maximum. The daily fecal fat excretion ranged from 2.20 to 24.8 Gm. per day, or from 0.55 to 6.20 per cent of the amount ingested. The results in four subjects are shown in Figure 1. All of the patients were maintained in positive nitrogen balance on a fixed intake of 70 Gm. of protein daily, with an average positive balance of 3.46 Gm. of nitrogen per day. The mean daily positive nitrogen balance ranged from 1.39 to 5.04 Gm. These results are also shown in Figure 1.

In all six patients the weekly fasting blood studies revealed no increase in total fat, neutral fat, phospholipid, or cholesterol. There was no consistent change in serum total protein, A/G ratio, N.P.N., fasting blood sugar, CO_2 content, sodium, potassium, or chloride. All determinations of urine urobilinogen remained within normal limits. Urinary ketones were only occasionally detectable in trace amounts, and disappeared with increased fluid intake. These results are shown in Table II.

All of the B.M.R. determinations remained within normal limits, but apparently increased slightly within these limits initially during the course of the feeding of the individual, and then returned to control levels. The mean respiratory quotient while the feedings were in progress ranged between 0.76 and 0.83. These results are also in Table II.

TABLE II

Days on feeding	Control	Days 7-10	Days 15-17	Days 20-24
No. of subjects	5	5	4	2
Esterified fatty acid, total mEq./L.	11.71	7.59	8.55	10.33
Phospholipid phosphorus, mg. per 100 cc.	7.12	6.01	5.63	7.32
Cholesterol, total, mg. per 100 cc.	189.	122.	157.	177.
CO_2 content, Vol. per 100 cc.	61.7	58.5	63.4	63.6
Non-protein nitrogen, mg. per 100 cc.	42.0	37.4	35.3	39.0
Fasting blood glucose, mg. per 100 cc.	56.0	64.5	63.0	72.0
Total serum protein, Gm. per 100 cc.	7.12	7.18	7.35	7.05
B.M.R.	+3	+14	+1	+2
R.Q. (respiratory quotient)	0.80	0.75	0.83	0.76

The results of the study of the last patient are shown in Figure 2. During the period when he was consuming 1000 ml. or more of the fat emulsion and supplements there was a slow gain in weight. As the intake was increased, nitrogen balance became positive and more fluid was retained. This can be seen readily on day 15 when 1500 ml. of the emulsion (600 Gm. of fat) and supplements were ingested. Fecal fat attained a maximum average daily excretion of 6.71 Gm. during the last nine days of study.

Discussion

The attainment of a markedly positive nitrogen balance while on a total daily intake of 70 Gm. of protein further confirms the well-known effect of increased caloric intake upon nitrogen balance. Previous workers[19-21] have shown that without change in daily protein intake, nitrogen balance can be converted from negative to positive by caloric supplementation. The use of fat emulsion in this study has made practicable the administration of a high calorie liquid diet. Previous studies have shown little change in fecal fat on diets containing 100 to 200 Gm. of fat per day;[22-24] however, there are only a few studies on diets containing over 300 Gm. of fat per day.[25] While the protein intake might be decreased and nitrogen balance continue to be positive if the caloric intake remained at high levels, further studies are needed to determine the minimal amount of protein intake which is necessary to keep these patients in positive balance while on this caloric intake.

It is of interest that none of these patients had an increase in their fasting blood levels of total or neutral fat, phospholipid, or cholesterol. The lack of an increase in cholesterol while on a high daily fat intake is of particular interest in view of recent reports[26,27] that dietary fat restriction is necessary in order to effect a decrease in the elevated chol-

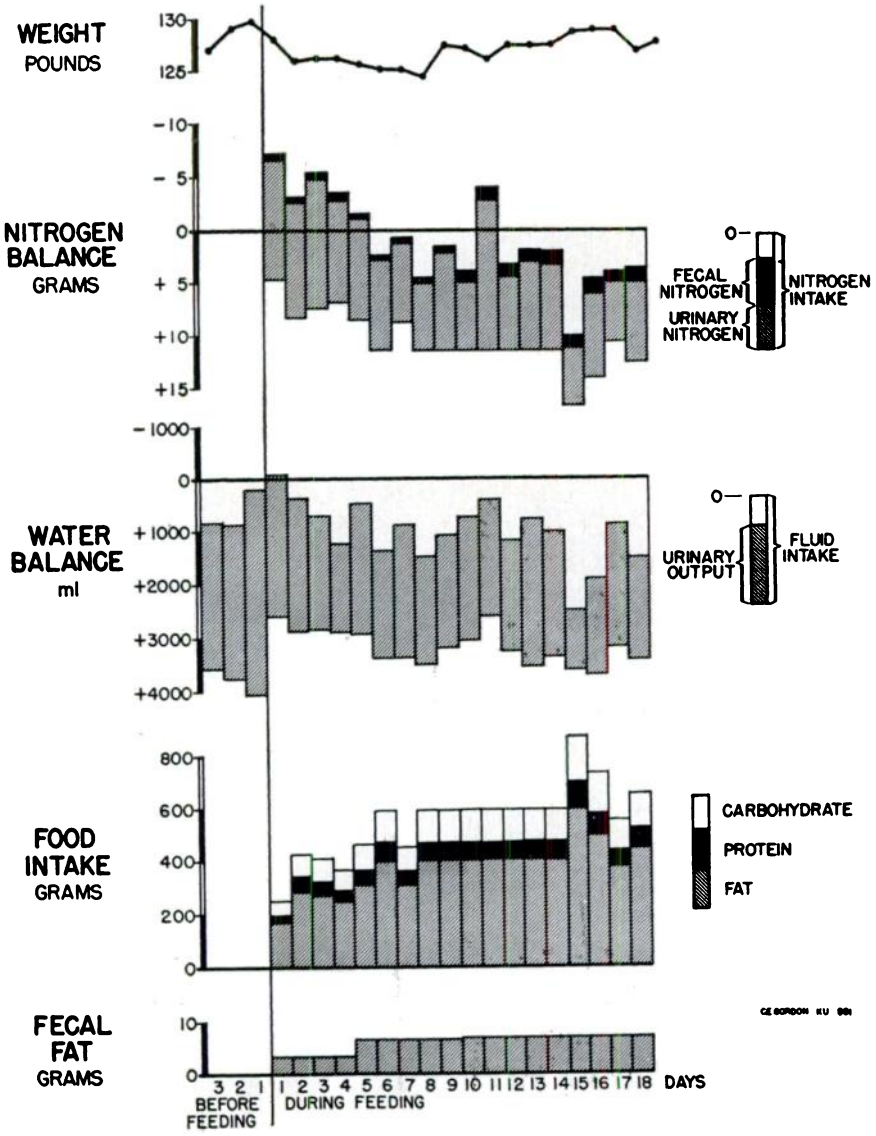

Fig. 2. Balance studies on patient F. R.

esterol levels observed in some diseases.

Intolerance to fat emulsion is a major difficulty, with nausea, vomiting, and diarrhea or constipation as the most frequently encountered symptoms. In some patients the onset of these symptoms is apparently unrelated to the size of the dose ingested and not correlated with demonstrable gallbladder disease. With prolonged ingestion, as in this study, the monotony of flavor becomes a problem in some patients, but the use of a chocolate flavor usually obviated this difficulty.

Another difficulty in the use of the emulsion is that, although stable when stored at ordinary temperatures, gradual separation of the fat occurs after the emulsion has been mixed with protein concentrate and electrolytes. After storage with refrigeration for from 30 to 48 hours, this separation necessitates the discarding of the mixture, and makes daily preparation of the mixture advisable.

Summary

A high calorie liquid diet, consisting primarily of a 40 per cent fat emulsion, was administered as the sole source of feeding to

six patients with fracture of the mandible.

While ingesting 400 Gm. of fat, 70 Gm. of protein, and 122 Gm. of carbohydrate, an increase in weight and marked positive nitrogen balance was noted in all subjects. Fecal fat excretion increased 7.68 Gm. above the control level as a maximum.

No consistent changes occurred in fasting blood levels of total or neutral fat, phospholipid, cholesterol, serum total protein or A/G ratio, N.P.N., fasting blood sugar, or CO_2 content.

ACKNOWLEDGMENT

This study was carried out in conjunction with a study with Dr. Irving F. Stein, Jr., and Dr. Edward M. Goldberg on the oral use of fat emulsion in surgical patients, the results of which were presented at the New York Academy of Sciences, Conference on Oral Fat Emulsions[28].

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RESUMEN

El empleo de una emulsión oral rica en grasa y en calorías para la alimentación total

Una dieta líquida rica en calorías, constituida principalmente por una emulsión de 40 por 100 de grasas, fué administrada como única fuente alimenticia a 6 pacientes con fractura de mandíbulo.

Mientras injerían 400 grs. de grasa, 70 grs. de proteina, y 122 grs. de hidratos de carbono, se notó en todos los sujetos un aumento de peso y un marcado balance positivo de nitrógeno. La excreción de grasa en las heces aumentó 7,68 grs. por encima del nivel de control, como máximo.

No se produjeron cambios uniformes en los niveles sanguíneos, en ayunas, de la grasa total o neutra, de los fosfolípidos o del colesterol, de las proteinas totales del suero, del cociente Alb/Glob., del nitrógeno no-protéico, de la glucemia en ayunas, o del contenido de CO_2.

Curiosity and Mystery

"Only children and philosophers seem interested in why ordinary things are, rather than are not. The rest of mankind is too busy with its real and little affairs to listen to their metaphysical questions or those of nature. Not only extraordinary deaths and marvelous cures but all the predicaments of patients, whether horrible or pleasing, in the thoughtful and detached view, beget a lively awareness of the mystery at the heart of being and lend devoutness to the traditional confession of faith: 'We dress the wound, God heals it.'"
—Editorial: On Extraordinary Deaths and Marvelous Cures. *New England Journal of Medicine* 247: 1045, 1952.

Fat and Fashion

"In former generations, judging by literary evidence, a moderate degree of obesity was scarcely regarded with distaste. It would probably be going too far, of course, to say that we have ever approached the attitude of the Chinese, who apparently regard fatness not only as desirable in itself because of the well-being, or the alleged well-being it implies, but also as an outward and very visible sign of prosperity and success in life. What is the use, ask the Chinese, of being rich if you are not also fat? And in a country in which starvation is endemic the question is not so absurd as it might appear. To-day in this country such an attitude would border on heresy."
—Editorial. *The Medical Press* 228: 471, 1952.

Complications of Dietary Calculations

"Of course the list of permitted vegetables can be endlessly enlarged, but the patient will pay too heavily for the pleasure of eating, for instance, red-peppers if he has to memorise a long list, especially as he will forget it and honestly believe it includes sweet corn. Again bread and potatoes may be exchanged for the right amount of any prohibited food but neither doctors nor patients have the time to remember that one ounce of bread equals three ounces of boiled macaroni, two and a half ounces of boiled lentils, or three quarters of an ounce of uncooked rice. Unemployed hypochondriacs can buy their own food tables and weigh all their food, though it will drive their families mad."
—F. Bicknell. *The Medical Press* 228: 492, 1952.