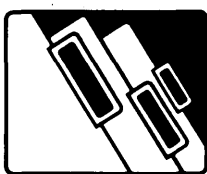


## Case Report



# Diet-Induced Essential Fatty Acid Deficiency in Ambulatory Patient With Type I Diabetes Mellitus

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We report a case of symptomatic essential fatty acid deficiency (EFAD) occurring in a free-living individual with type I diabetes mellitus who was voluntarily following a high-carbohydrate, fat-restricted diet. The patient was 43 yr old with type I diabetes for 18 yr and no chronic complications. His self-imposed diet excluded all red meats, fats, and oils. After several months of this diet, the patient developed lethargy and a pruritic, diffuse, scaly, and erythematous rash. Biochemical studies revealed a mildly elevated SGOT and abnormally low levels of linoleic, linolenic, and arachidonic fatty acids. Treatment with linoleic acid supplementation in his diet improved the rash, normalized SGOT, and corrected the fatty acid profile. We conclude that EFAD may occur in a free-living individual after consuming a very-low-fat diet. *DIABETES CARE* 1986; 9:291-93.

**T**issue stores of essential fatty acids in humans are large; dietary needs are estimated at only 1-2% of total calories ingested.<sup>1-3</sup> It is therefore difficult to induce essential fatty acid deficiency (EFAD) in healthy, free-living individuals. The majority of reported cases of EFAD have occurred in adults receiving prolonged fat-free intravenous hyperalimentation or in healthy volunteers fed experimental fat-free oral diets.<sup>4-6</sup> To our knowledge, no documented cases of spontaneously occurring EFAD have been reported in otherwise healthy adults. We report here a case of EFAD occurring in a 43-yr-old insulin-dependent diabetic patient who was voluntarily following a high-carbohydrate, very-low-fat diet.

### CASE HISTORY

The patient was a 43-yr-old man with an 18-yr history of uncomplicated type I diabetes mellitus. He visited a longevity center for 1 mo in March 1983; there he began to exclude all red meats, fats, and oils from his diet and to replace them with large quantities of unrefined carbohydrates. He also started an intensive exercise program, which included jogging several miles daily. Over the next 4 mo, he noted the gradual onset of lethargy and fatigue, which forced him to discontinue his exercise program. He also noted the appearance of a pruritic, scaling rash over his arms, legs, and trunk; this rash was unresponsive to steroid creams.

A diet history, including 24-h diet recall, revealed a diet

containing approximately 1960 cal/day and consisting of approximately 72% carbohydrate, 21% protein, 7% fat, and 0.7% linoleic acid. He varied little in his food choices from day to day (Table 1). He was taking no medication other than insulin (32 U total) taken as a combination of ultralente insulin twice a day and regular insulin before each meal. Physical examination was normal except for a mild, minimally erythematous, dry scaling dermatosis on the scalp, extremities, and trunk. Routine laboratory studies were within normal limits except for a mild elevation of SGOT (56  $\mu$ U/ml, normal <40  $\mu$ U/ml) and SGPT (43  $\mu$ U/ml, normal <36  $\mu$ U/ml) and low plasma cholesterol (116 mg/dl). Alkaline phosphatase, LDH, total bilirubin, and albumin were within normal limits. Hemoglobin A<sub>1c</sub> was 7.5% (normal range for our laboratory 4-6%). There was no anemia or thrombocytopenia.

Essential fatty acid deficiency was suspected in this patient because of his scaling dermatosis, mild hepatic dysfunction, and severely limited linoleic acid intake. Serum lipid fatty acid profile was performed at the Mayo Medical Laboratories, Rochester, Minnesota.<sup>7</sup> A diagnosis of EFAD was made on the basis of low linoleic, linolenic, and arachidonic acid levels and a high triene:tetraene ratio (Table 2).<sup>3,8</sup>

The patient did not wish to include vegetable oils or margarines in his diet, both excellent sources of the essential fatty acids. Therefore, a diabetic exchange system was developed, incorporating specified amounts of seven types of seeds and/or nuts, providing a dietary source of linoleic acid.

He was instructed to include one of the exchanges with each meal to raise his linoleic acid intake to approximately 7.5 g/day (3% of estimated caloric needs). This was well-accepted by the patient.

Within 1–2 wk, the patient noted less pruritus and gradual disappearance of the rash, and within 1 mo his energy level returned to baseline. Repeat physical examination was normal. Repeat laboratory testing 3 mo later showed improvement of SGOT (43 U/ml) and normalization of essential fatty acid profile (Table 2).

#### DISCUSSION

Essential fatty acids in humans include linoleic, linolenic, and arachidonic acids. Linoleic acid is believed to be the limiting fatty acid that must be obtained in the diet.<sup>1,3</sup> Estimated requirements for healthy adults are 1–2% of total calories, or 3% if total fat intake is <25% of total calories.

Essential fatty acid deficiency has been induced experimentally in animals and in hospitalized patients receiving fat-free intravenous hyperalimentation.<sup>4,5,9</sup> It has also been induced in healthy volunteers fed experimental oral fat-free diets for a prolonged time,<sup>6</sup> and there has been one report of

TABLE 1  
Twenty-four-hour diet recall

Breakfast	
½ cup Grapenuts	
1 slice whole-wheat bread	
2 grapefruit	
2 tbs Brewer's yeast	
Lunch	
2 oz. tuna (water packed)	
3 slices whole-wheat bread	
1 cup cooked asparagus	
1 cup cooked broccoli	
1 cup lettuce and tomato salad	
1 fresh peach	
¼ honeydew melon	
Snack	
1 apple	
2 slices whole-wheat bread	
Supper	
2 oz. cod	
1 small baked potato	
1 cup white rice	
1 cup cooked asparagus	
1 cup cooked broccoli	
1 cup lettuce and tomato salad	
1 fresh peach	
¼ honeydew melon	
Snack	
1 fresh pear	
2 squares graham crackers	

TABLE 2

Fatty acid profile of serum lipids before and after diet supplements with linoleate-rich foods

Fatty acid	Before	After	Normal
Linoleic*	6.6	27.8	>25
Linolenic*	0.1	1.4	>1
Arachidonic*	0.04	7.1	>6
Triene:tetraene ratio	10	0.15	<0.2

\*Percent of total.

an asymptomatic patient with gastrointestinal disease and low normal essential fatty acid levels.<sup>10</sup> To our knowledge, there have been no other reports of symptomatic EFAD occurring in ambulatory and otherwise healthy individuals. Symptoms and signs of EFAD include most commonly a scaling, pruritic dermatitis, increased tendency of infection, poor wound healing, anemia, thrombocytopenia, hepatocellular dysfunction, and fatty infiltration of the liver, as well as poor calorie utilization.<sup>3</sup> The mechanisms for many of these observed phenomena is not clear. Some may relate to membrane structure alterations and some to alterations in prostaglandin synthesis.<sup>3,11</sup>

Information is lacking on the effect of diabetes on the tendency to develop EFAD. Animal studies have suggested that a diet deficient in essential fatty acids produces more marked biochemical abnormalities in diabetic than in non-diabetic animals; however, in the absence of a deficient diet, diabetes itself does not seem to predispose to the development of EFAD.<sup>12</sup> The patient in our study was also following an intensive insulin therapy regimen, and this may have contributed to the development of symptoms. High plasma insulin levels depress the release of fatty acids from adipose tissue stores<sup>3</sup> and this may affect plasma essential fatty acid levels. In addition, recent studies in animals with experimentally induced diabetes suggest that insulin treatment may potentiate the effect of a diet deficient in essential fatty acids on liver stores of essential fatty acids.<sup>13</sup>

The symptoms and signs of EFAD in this patient were classic. However, he is unusual in that his calculated fat intake was only 7% of total calories. His intake of linoleic acid was 0.7% and therefore <25% of his estimated needs. After 1 mo of linoleic supplements, his symptoms abated and his rash disappeared. After 3 mo, his liver function tests and plasma fatty acid profile were improved. The most common clinical setting for EFAD is the individual hyperalimented without lipid solutions. This report suggests that EFAD may also occur in an ambulatory individual after a very low-fat dietary regimen.

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