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Metabolic and hormonal effects of fasting in obese children

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A 30 hour fast induced a significant and comparable fall in blood glucose and branched-chain amino acid levels in both obese and control children, while the plasma levels of glycerol, lactate, pyruvate, cholesterol, HDL-cholesterol and the rest of the amino acids remained unchanged.

Sustained hyperinsulinism, sustained higher triglyceride levels and a lower degree of FFA mobilization characterized the plasma of obese children during fasting.

Obesity in childhood has become a significant problem in the developed countries. This is apparent when one realizes that 80% of overweight children become overweight adults [1]. In spite of the increasing problem of exogenous obesity, therapy is by no means solved. Radical therapies such as protein sparing fast, and prolonged total starvation should be approached with caution in children because of the known and unknown side-effects. Simple caloric restriction, e.g. 1200 or 1000 Kcal per day, hardly produces any weight loss in sedentary, grossly obese individuals. Heyden et al. [16] proposed low-calorie diet with intermittent fasting days each week. The inclusion of intermittent fasting showed impressive results and was acceptable for children after due instruction. Before applying the intermittent fast in the therapy of obesity, we wanted to investigate the metabolic and hormonal changes induced by a 30 h fast, since there is only one report on the metabolite and hormone levels during the first day of total starvation in obese children [5].

Material and Methods

Twenty obese (relative body weight beyond 120%) and 5 non-obese children were investigated. Their age and anthropometric parameters are given in Table I. The children were kept on a 80 Kcal/kg diet of constant composition (50% carbohydrate, 30% fat and 20% protein) for two days prior to the test. The 30 hour fast started at 6 a.m. after consumption of the breakfast and continued until noon of the second day. Blood samples were collected at 6, 12, 24 and 30 h for the

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TABLE I
Anthropometric data of obese and control children

	Control		Obese	
	Mean	± S. E.	Mean	± S. E.
Age, yr	10.6	0.63	10.7	0.45
Height, cm	142.7	3.01	148.4	2.63
Weight, kg	32.9	2.23	60.8	3.3
Triceps skinfold, mm	10.0	0.7	28.9	1.03
Biceps skinfold, mm	5.6	0.37	15.6	0.87
Subscapular skinfold, mm	8.3	0.66	31.5	1.01
Suprailiacal skinfold, mm	9.4	0.83	27.7	1.58
Body fat, per cent	20.01	1.29	40.5	0.77
Lean body mass, kg	26.2	1.58	37.1	2.03
Ideal body weight, per cent	89.9	2.5	148.9	3.77

measurement of glucose, immunoreactive insulin (IRI), FFA, lactate, pyruvate, cholesterol, high-density lipoproteincholesterol (HDL-cholesterol), triglyceride and glycerol. Anthropometric measurements and determination of plasma metabolites (glucose, FFA, lactate, pyruvate, IRI, cholesterol, triglyceride, glycerol) were made as described previously [23]. After heparin-manganese chloride precipitation [30] HDL-cholesterol was determined in the supernatant by the cholesterol oxidase method using the Galenofarm HDL-cholesterol test [22]. Ames Acetest tablets were used to assess urinary ketone excretion. Individual free amino acids were measured by automatic ion-exchange column chromatography.

The mean and standard error (S.E.) were calculated with standard methods. The statistical significance of the difference between the means of the groups were evaluated according the Student's t test.

RESULTS

The 6 hour fasting values for glucose, FFA, glycerol, lactate, pyruvate, cholesterol and triglyceride were not different in obese and control children. Plasma IRI was significantly higher, HDL-cholesterol significantly lower in the overweight children as compared to the controls at the 6th hour of fast (Figs 1 and 2).

Blood glucose decreased in both groups, but more significantly in the control children (Figure 1).

Decrease of the IRI concentration was marked already in the first 12 h of the fast in the controls, while in the adipose children it proved to be significant only after 30 h (Fig. 1). The IRI level of obese children remained significantly higher than that of controls throughout the whole fasting period.

The starvation-induced increase of FFA concentration was significant in the control children while the increase in glycerol was insignificant in both adipose children and the controls (Fig. 1).

Plasma lactate, pyruvate, cholesterol and HDL-cholesterol (Fig. 2) did

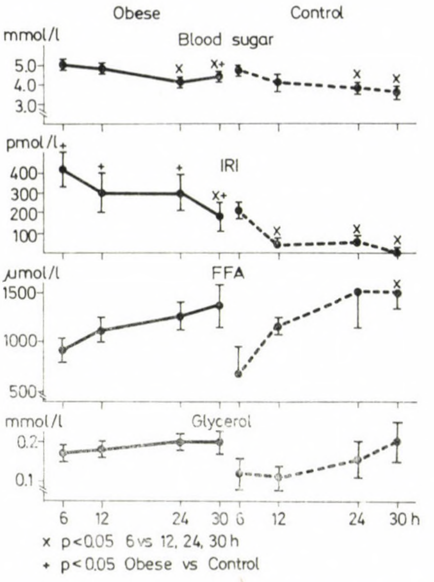

FIG. 1. Effect of fasting on blood glucose, IRI, FFA and glycerol levels (M ± S. E.)

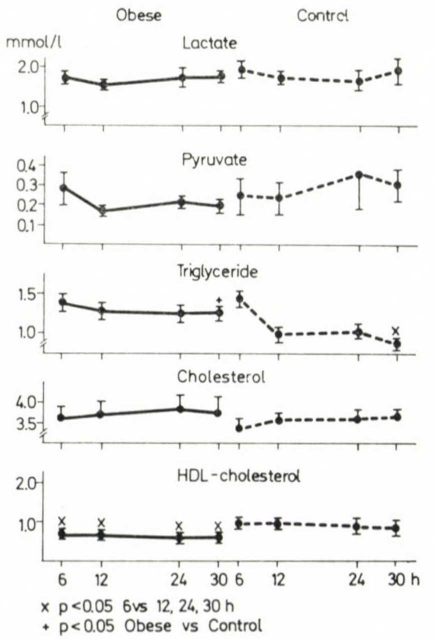

FIG. 2. Plasma levels of lactate, pyruvate, triglyceride, cholesterol and HDL-cholesterol during fasting (M ± S. E.)

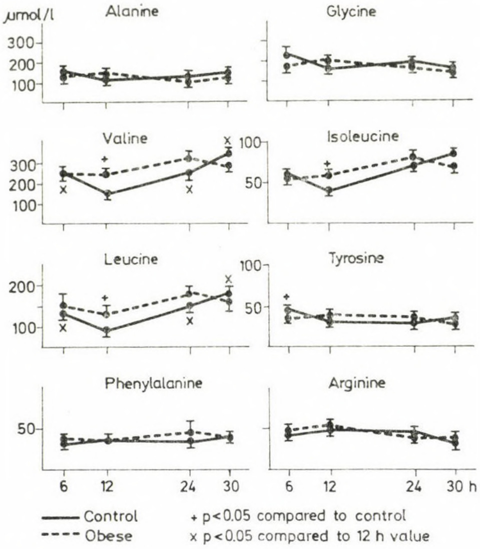

FIG. 3. Effect of fasting on the plasma free amino acids levels (M ± S. E.)

not change significantly during the 30 h fast in either group.

Triglyceride concentration fell significantly in the controls and remained unchanged in the obese children (Fig. 2). The triglyceride levels of overweight children were still significantly higher than that of the controls at the end of the 30 h fast.

The plasma levels of most amino acids were not modified by the fast in any of the groups (Fig. 3). Only the branched-chain amino acids showed an initial tendency to fall in the first 12 hours and a continuous rise throughout the next 18 hours. These changes were similar in the two groups, but proved to be significant only for leucine and valine in the control children.

Clinically, no side-effect was observed during the fast except for a mild ketonuria in 3 obese and 2 control children.

DISCUSSION

Blood glucose decreased during the fast in both obese and control children, but the fall in blood glucose was significantly less in obese children, in agreement with earlier reports [5, 13].

Hyperinsulinaemia [3, 6–8, 26 27,] one of the well known abnormalities in obesity, was apparent in the adipose children. It was shown previously [6, 10, 15, 19] that restoration of biochemical and hormonal changes including hyperinsulinaemia associated with obesity could be achieved by starvation, caloric restriction and/or weight reduction. Hyperinsulinaemia decreased significantly during a 30 h starvation in the present study, but plasma IRI levels were still above normal at the end of the brief starvation period. So it was shown that a 30 h fast was capable of reducing the insulin level in obese patients as it has been reported in obese and diabetic obese adults [13, 14].

The blunted increase of FFA and glycerol during starvation in the obese group, together with our previous observation of a negative correlation between fasting FFA and adiposity [23] and an insignificant rise of FFA at the end of the glucose tolerance test [24], are suggestive of an impaired lipolysis in overweight children. Apart from a slight FFA mobilization during short periods of starvation [12, 13, 18], a decreased fatty acid release from adipose tissue was found in genetically obese animals [21], but others could not confirm these observations [25, 17, 4].

It is generally accepted that starvation for 3—6 days causes a rise in serum cholesterol and no change or a rise in serum triglyceride concentration [20, 9, 29]. We did not find any change in the cholesterol level of either group, probably because of the shortness of the fast. The significantly lower HDL-cholesterol level found in the present investigation is in agreement with other reports [12, 28]. The short-term starvation was without effect on the HDL-cholesterol values in both the obese and the control children.

Similarly, few changes could be observed in the level of most of the amino acids studied. Only the branched-chain amino acid levels were modified characteristically but, in contrast with a previous observation [5], these changes were modest and not significant in the obese children. There was also a tendency to decline in the level of alanine, glycine and tyrosine, but these changes were not significant. The apparent difference between our findings and those of Chaussain et al [5] is difficult to explain. The different body fat content of the children in the two studies is also difficult to compare on the basis of the data available. Besides, the changes of most of the other metabolites and hormones studied were also slighter in our study than in that of Chaussain et al [5].

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