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Ketone body metabolism in lean male adults during short-term starvation, with particular reference to forearm muscle metabolism

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Abstract

1. Thirty-three arteriovenous forearm catheterization studies were carried out in 19 lean subjects starving for 12–14 h(n = 13), 30–36 h (n = 7) and 60–66 h (n = 13). Forearm blood flow was measured in order to calculate the flux of various substrates. At the same time, whole-body oxidation of fat, carbohydrate and protein was calculated using indirect calorimetry and urinary nitrogen excretion.

2. After an overnight fast (12–14 h), whole-body resting energy expenditure was accounted for by the oxidation of protein (15%), carbohydrate (17%) and fat (68%). At 30–36 h and 60–66 h of starvation, essentially all the non-protein energy was derived from the oxidation of fat (directly plus indirectly via ketone bodies).

3. After an overnight fast, acetoacetate and 3-hydroxybutyrate were taken up by forearm muscle at a rate which could account for 5% of the resting O_2 consumption of this tissue. As starvation progressed, forearm muscle took up more acetoacetate and released 3-hydroxybutyrate so that the net uptake of ketone bodies was sufficient to account for about 10% of the resting O_2 consumption at 30–36 h of starvation and about 20% at 60–66 h of starvation.

4. The uptake of circulating non-esterified fatty acids by forearm muscle accounted for a greater proportion of the forearm O_2 consumption than the uptake of ketone bodies at all times studied. The release of lactate and alanine was significantly greater at 36–40 h and 60–66 h of starvation compared with 12–14 h of starvation, but that of glucose did not change significantly.

5. The results suggest that during early starvation: (a) the release of 3-hydroxybutyrate by muscle (36–66 h starvation) contributes to the circulating 3-hydroxybutyrate concentration, (b) the contribution of ketone bodies to oxidative metabolism in lean subjects is variable but considerably lower than the generally accepted values in obese individuals, and (c) the dominant energy source for the resting muscle of lean individuals between 12 and 66 h of starvation is non-esterified fatty acids.

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