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Research Articles

Analysis of energy expenditure, endocrine function, and autonomic nervous activity in anorexia nervosa patients during refeeding

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Abstract

Resting energy expenditure (REE) increases in anorexia nervosa patients after refeeding; however, the associated mechanisms remain unclear. We hypothesized that changes in autonomic nervous activity are relevant to changes in REE during refeeding. The objectives of this study were (1) to confirm differences in REE during refeeding and (2) to identify the parameters associated with these differences. The subjects were 9 female inpatients with anorexia nervosa receiving cognitive-behavioral therapy. Both before and after the start of refeeding, which was defined as the first increase in food intake of 1675 kj or more per day, body composition, REE, endocrine function, R-R interval, autonomic nervous activity evaluated in terms of heart rate variability, and physical activity were measured and psychological tests completed. The differences in measurements before and after refeeding and specific associations between changes in REE and other factors were assessed. Resting energy expenditure increased significantly by 22.7% from 3190 to 3910 kj/d ($P < .01$) with the increase in energy intake. Fat-free mass and physical activity did not change. The increase in REE was accompanied by higher insulin-like growth factor-I, free triiodothyronine, and norepinephrine and decreases in parasympathetic activity and R-R interval. Some factors might be responsible for the increases in REE observed

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with refeeding. No previous study has simultaneously observed multiple variables related to energy metabolism during refeeding.

Keywords: Anorexia nervosa; Refeeding; Resting energy expenditure; Norepinephrine; Autonomic nervous activity

1. Introduction

Anorexia nervosa (AN) is characterized by an extreme body weight loss, an intense fear of gaining weight, a disturbed body image, and amenorrhea, with an abnormal eating behavior [1]. In the course of cognitive-behavioral therapy to gain weight toward their target body weight for AN patients, it is important to increase energy intake by refeeding. During refeeding, AN patients require a high energy intake due to poor weight recuperation [2,3]. Several studies have investigated resting energy expenditure (REE) as the underlying etiology of AN as it relates to refeeding [4-7]. Satoh et al [4] showed that REE of AN patients during the refeeding phase (5150 kj/d) was significant higher than before refeeding (3475 kj/d) and was not different from controls (5589 kj/d). Van Wymelbeke et al [5] showed that REE significantly increased by 13.4% from baseline to the refeeding phase ($P < .01$) in AN patients whereas fat-free mass (FFM) increased by 1.6%, and the ratio of REE to FFM remained high. Obarzanek et al [6] reported that the ratio of REE to FFM of AN patients on admission (95.9 kj/kg per day) was not different from that of healthy subjects (104 kj/kg per day) and that of AN patients during early refeeding (108 kj/kg per day), whereas that of AN patients during late refeeding (132 kj/kg per day) was significantly higher than on admission. Polito et al [7] reported that REE of AN patients before refeeding, that of recently rehabilitated AN patients (during refeeding), and that of control subjects were 3927, 4649, and 4970 kj/d, respectively. When REE was expressed per unit of FFM involved in energy metabolism, the unit per FFM was 114, 123, and 121 kj/kg per day, respectively, and when REE was adjusted by analysis of covariance for FFM, the values were 4208, 4677, and 4748 kj/d, respectively. These results suggest that REE of AN patients before refeeding was significantly lower than the control and that after refeeding even after corrected by FFM [7]. Therefore, the increase in energy expenditure observed with refeeding is unlikely to be attributable only to the increase in FFM, and previous studies have examined possible relationships between energy expenditure and neuroendocrine parameters.

The changes in leptin levels during refeeding remain controversial. One-week refeeding did not improve AN patients' leptin levels [8] and so were unlikely to be responsible for the increase in REE [4,8]. Lob et al [9] reported that serum leptin levels increased during refeeding based on observations every 2 weeks for 3 months. However, this accompanied the increase in body mass index (BMI), and they concluded that high leptin levels did not predispose to a renewed loss of weight during refeeding [9]. Even when leptin increased during long-term, it did not affect the patients' body weight. Satoh et al [4] showed that leptin levels did not reach levels of healthy subjects even after recovery of body surface area in AN patients.

Although several studies reported increases in triiodothyronine (T_3) or free T_3 (FT_3) with refeeding, they failed to demonstrate correlations between REE or the ratio of REE to FFM