Quick Response of Fat Tissue to Treatment of Thyroid Disorders and to Dieting in Obesity

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The clinical courses of a patient with simple obesity and four patients with thyroid disorders were followed up, during treatment, for looking into the effects of dieting and thyroid hormone on a turnover of fat tissue. We obtained the following results. Reduced body weight in an originally obese patient with hyperthyroidism should be owing mostly to a reduction in fat tissue. In the case of abnormal thyroid function of the obese, the affected fat tissue quickly responds to an appropriate therapy. On the other hand, emaciation in an originally lean patient with hyperthyroidism should be due mainly to a reduction in muscle tissue, which gradually improves with treatment. Thus thyroid hormone plays an important role in the regulation of serum lipids and volume of fat. In the case of treatment of obesity, we have an impression that caliper measurement by a physician can in itself have a good effect on controlling body weight.

Key words: Fat Tissue, Caliper Measurement, Emaciation, Obesity, Thyroid Hormone

INTRODUCTION

As we reported in the previous paper (Nakashima *et al.*, 1984), variation of thyroid hormone even within normal range could affect body fat, and the fat of young people can be reduced in a relatively short term. We do not yet know, however, the correct term necessary for reducing the fat. One purpose of the present experiment is to figure out how rapidly the young obese can wear off the fat.

Similarly, we have little information about how quickly body fat responds to a change in serum thyroid hormone. It is the other aim, therefore, to make this point clear by following up the change in body fat of patients with thyroid disorders during treatment.

METHODS

The method using a caliper for estimating body fat was described previously (Nakashima *et al.*, 1984) and the reliability of the method was confirmed to be fairly good. The skinfold thickness of the upper arm and subscapular area was determined on the right side of the body. Based on the data, body density (D) was calculated according to the method of Nagamine and Suzuki (1964) to predict how much percent of body mass was occupied by fat (Keys and Brožek, 1953) (D in male = $1.0913 - 0.0016 \times \text{sum}$ of the skinfold thickness, D in female = $1.0897 - 0.00133 \times \text{the sum}$, and per cent distribution for fat = $457.0/D - 414.2$). All caliper measurements were done by one physician. Blood samples were obtained during fasting time in the morning to measure the amount of thyroid hormones and lipids. In order to

minimize the term for normalizing the function of patients with hyperthyroidism, they were given a large dose of iodide tablets containing 10 mg KI each (Kyushu University Medical School and the Kyushu Central Hospital Pharmaceutical Departments).

CASE STUDIES AND DISCUSSIONS

A 25 year old, unmarried nurse consented to put herself on a diet for more than half a year, she was 158 cm tall, weighing about 70 kg on her first visit. Several years before that, she weighed 55 kg, but started to gain weight from overeating. She changed her diet from taking foods ad libitum to taking just

1600 cal of food per day, but after 1 month there was no weight loss. Subsequently, she started to prepare 1100–1200 cal per day for herself (carbohydrate 150–160 g, fat 30–40 g, protein 50–60 g) for 2 months, and then 800–1000 cal of similar composition. A quick response of serum lipids and body fat to the dieting was observed as shown in Fig 1. Decrease in the levels of total cholesterol and triglyceride reached a state of equilibrium between 15 and 20 weeks, whereas body weight and fat had decreased up to 27 weeks, then reached an equilibrated state. Body weight decreased from 69.5 kg to 47.0 kg, the fat from 37.1% to 19.2% after 27 weeks on the diet (Actual reduction: fat; 25.8 kg–9.0 kg=16.8 kg,

Fig. 1. The effect of dieting on a patient with simple obesity. Key to designations: $\triangle$ — $\triangle$ triglyceride (normal range; 50–170 mg/100 ml), $\blacktriangle$ — $\blacktriangle$ total cholesterol (normal range; 130–250 mg/100 ml), $\bullet$ — $\bullet$ body weight (kg), $\circ$ — $\circ$ fat (per cent of body weight), $\odot$ — $\odot$ T_4 (normal range; 4.5–12.5 μ g/100 ml), $\bullet$ — $\bullet$ T_3 (normal range; 0.7–2.1 ng/ml), $\otimes$ — $\otimes$ rT_3 (normal range; 14–39 ng/100 ml)

body weight ; 69.5 kg-47.0 kg=22.5 kg). Thus, 75% of weight reduction was owing to the decrease in fat. Thyroxine (T_4) level was fairly stable. Triiodothyronine (T_3), however, decreased, as reported by Vagenakis *et al* in starvation (1975). Reverse T_3 (rT_3) increased. Thus, it is obvious that the rT_3/T_3 ratio is a more sensitive indicator of poor nutritonal state than the T_3/T_4 ratio (Nakashima *et al.*, 1984). In the previous study, we observed a sort of managing effect on the weight reduction of the obese after a caliper measurement. This result and our observation in the present case gave us the impression that a caliper measurement by a physician could in itself have a psychologically positive effect on controlling body weight by dieting.

Fig 2-1 shows the clinical course of a 24 year old male with hyperthyroidism (case 1). He is 164 cm tall and has lost 6.4 kg from 68 kg in the past 4 months. Administration of 60 mg of KI a day rapidly reduced T_4 and T_3 to normal levels within one week, while the treatment raised total cholesterol in serum and body fat. They reached a maximal level 5 weeks later. Finally, increase in fat was 6.0 kg, corresponded to 79% of the increased body weight, 7.6 kg. Thus, serum lipids and body fat responded to a change in serum thyroid hormone very quickly. Furthermore, the patient seemed to lose weight mostly by the reduction of fat tissue rather than muscle tissue under hyperthyreoidic state.

Fig 2-2 also shows the course of a hyperthyreoidic

Fig. 2-1.

The clinical courses of patients with hyperthyroidism under KI treatment. As shown in Fig 2-1 and 2-3, originally obese patients have a rapid increment of fat tissue with a decrease in the thyroid hormone levels. On the other hand, changes in an originally lean patient in Fig 2-2 are slow.

patient (case 2). This patient was almost equivalent to case 1 in terms of sex, age, height, T_4 and T_3 , except for lighter body weights both before and after the onset of hyperthyroidism: 5.6 kg and 5.0 kg (case 2) v.s. 68.0 kg and 61.6 kg (case 1).

By the administration of 60 mg KI daily, the serum T_3 was normalized within 2 weeks and T_4 within 4 weeks. It was characteristic of the patient that serum lipids including total cholesterol and the fat tissue, changed slowly and took more than 12 weeks to reach an equilibrium even after normalization of the thyroid hormone level. The fat content increased from 10.6% to 13.6%. Subsequently, actual increase of fat was 2.3 kg, which corresponded to 38.6% of increased body weight, 6.0 kg. In contrast to case 1, this case seemed to owe the increase in body weight mostly to muscle tissue.

The results of the third patient with hyperthyroidism (case 3), a 17 year old female, are shown in Fig 2-3. She is 158.6 cm tall and recently lost 2.2 kg of

body weight from 58.0 kg. Daily administration of 60mg of KI normalized serum T_4 level within 2 weeks and rapid increase in fat tissue was observed. After all 10 weeks of KI treatment yielded increases in 2.5 kg of body weight and 1.86 kg fat, corresponding to 74.4% of the increased body weight. Thus, this case showed a quick response of fat tissue to a decrease in thyroid hormone, and the increment of body weight was mainly owing to an increase in the fat.

Table 1 shows the effect of KI on girth of upper arm in uncontracted and contracted states of the biceps. The latter state is supposed to reflect change in muscle tissue better than the former state. Case 1 and 3, with a tendency to obesity, showed a higher increase in the uncontracted state of the biceps than in the contracted state. On the contrary, case 2, a lean man, had a higher increase in the contracted state.

All these results suggest that originally obese

Fig. 2-2.

Fig. 2-3.

Table 1. Girth of upperarm* (Effect of KI treatment)

	Case 1	Case 2	Case 3
Uncontracted	+ 13.0%	+ 7.0%	+ 6.4%
Biceps	(26.2 → 29.6cm)**	(22.8 → 24.4cm)	(23.5 → 25.0cm)
Contracted	+ 4.4%	+ 10.6%	+ 4.7%
Biceps	(31.8 → 33.2cm)	(25.4 → 28.1cm)	(25.8 → 27.0cm)

* The measurement was initiated from contracted state of the biceps of the more dexterous arm, and then the uncontracted state.

** Before and after the treatment.

patients with hyperthyroidism, under the treatment, rapidly gain weight by an increase in the fat tissue, whereas the lean with hyperthyroidism slowly gain weight by an increase in the muscle under KI treatment.

Fig 3 shows the clinical course of a 39 year old female with hypothyroidism under T₄ replacement therapy. She was 152.5 cm tall and weighed 54.0 kg

with 15.77 kg of the fat (=29.2% of body weight) before the thyroid hormone replacement therapy. Total cholesterol, body weight, and fat started decreasing rapidly after the initiation of the therapy and reached an equilibrium 8 weeks after normalization of serum thyroid hormone level, when body weight was 50.0 kg with 12.90 kg of the fat (25.8% of body weight). Subsequently, the reduced fat 2.87 kg corresponded to 71.8% of the reduced body weight, 4.0 kg. On the other hand, the reduced body weight had to contain a significant volume of water in the hypothyreoidic, since the cardiothoracic ratio on X ray film significantly and quickly improved from 58.2% to 43.8% over 4 weeks. Taking account of this, we concluded that most of the solid component of the reduced body weight must be fat. In other words, muscle tissue should scarcely contribute to the weight gain in hypothyro-

Fig 3. The clinical course of a patient with hypothyroidism under T₄ replacement therapy. An elevation of serum thyroid hormone level results in rapid decreases in serum cholesterol and fat tissue.

idism, if at all.

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