Relationship between Thyroid Hormone and Body Fat in Young Japanese

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It is well known that excessively secreted thyroid hormone frequently reduces lipids in serum and deprives thyrotoxic patients of their body weight. On the contrary, hypothyreoidic patients show an elevated level of serum lipids and a gain in weight. Thus thyroid hormone is supposed to play an important role on body composition. It has yet to be studied, however, if a variation of thyroid hormones in a physiological range affects serum lipids and body fat. In order to make this point clear, the present experiment was designed.

METHODS

The skinfold thickness of the upper arm and subscapular area was determined on 464 Japanese college students; 413 males (18-31, 20.5 ± 1.8 years old) and 51 females (18-24, 19.5 ± 1.5 years old). The measurements were made on the right side of the body with a Minnesota caliper model calibrated to exert pressure of 10gm/mm^2 of jaw surface. Based on the data, body density (D) was calculated according to the method of Nagamine and Suzuki (1964) to predict how much per cent of body mass was occupied by fat (Keys and Brožek, 1953) (D in male = $1.0913 - 0.00116 \times \text{sum of the skinfold thickness}$, D in female = $1.0897 - 0.00133 \times \text{the sum}$, per cent distribution for fat = $457.0/D - 414.2$).

Five months later, serum thyroid hormones and lipids were determined during a period of overnight fasting on 19 volunteer students whose bodies were composed with a high or low percentage of fat. The high and low groups were designated as A ($n=4$) and a ($n=6$) in males, B ($n=4$) and b ($n=5$) in females, respectively. Their skinfold thickness was

determined again and the reliability of the results for fat percentage was confirmed by the underwater weight method. Statistical significance of the results was examined by student t test or Cochran cox's method.

RESULTS AND DISCUSSIONS

The fat tissue of male students was $15.4 \pm 2.93\%$ (Mean $\pm$ SD) of body weight, which was significantly lower than that of female students, $22.4 \pm 3.59\%$. However, the mean value of the female was lower than that we anticipated (Brožek *et al.*, 1953). Lean students (fat $< 10\%$) and the obese (fat $\geq 20\%$) among 413 males (Keys and Brožek, 1953) were 0.3% and 7.9%, respectively. On the other hand, among 51 females (Brožek *et al.*, 1953), the lean (fat $< 20\%$) were 20% and the obese (fat $\geq 30\%$) were 4%. Thus, of young Japanese we examined, male had a tendency to obesity whereas female tended to emaciate. Compared to young male, young female may have more interest in keeping her body slender, as the obese female students in the present experiment reduced the fat in a relatively short term shown in Table 1. In other words, on this occasion, we believe that an effect of education with health care was seen in the young females with obesity.

The percentages of the fat tissues of the four experimental groups were shown Table 1. That of group (B) at the day of the experiment was lowered remarkably and was almost equal to the mean value of all females initially determined. The fat of eighteen out of 19 subjects was also determined by the underwater weight method. The results by both methods were $18.9 \pm 1.25\%$ and $19.3 \pm 1.63\%$, respect-

Table 1. Body fat and Lipids in serum

	Fat (%)**		Total	Triglyceride	NEFA
	1st***	2nd****	Cholesterol		
normal range			130–250mg/dl	50–170mg/dl	0.2–1.0mEq/l
A(n=4)	26.2***** ± 0.218	25.4 ± 1.48	198 ± 25.9	145 ± 45.5	0.475 ± 0.215
B(n=4)	28.1 ± 1.06	22.7 ± 0.156	122 ± 4.69	35.0 ± 10.7	0.475 ± 0.149
	└ p<0.02 ─┘				
a(n=6)	10.7 ± 0.122	12.1 ± 0.507	114 ± 6.80	48.3 ± 10.0	0.483 ± 0.117
b(n=5)	17.1 ± 0.594	17.3 ± 0.706	146 ± 14.5	43.0 ± 9.46	0.580 ± 0.159
A–B			N.S.	N.S.*	N.S.
A–a			p<0.01	N.S.	N.S.
A–b			N.S.*	N.S.	N.S.
B–a			N.S.	N.S.	N.S.
B–b			N.S.	N.S.	N.S.
a–b			N.S.*	N.S.	N.S.

* p≦0.05 ** Per cent of total body weight *** Determined 5 months prior to the experimental day **** Determined at the experimental day ***** Mean±SE

Table 2. Serum thyroid hormone

	T ₄	T ₃	rT ₃	TSH	T ₃ /T ₄	rT ₃ /T ₃
normal range	4.5–12.5μg/dl	0.7–2.1ng/ml	14–39ng/dl	2–10mμU/ml		
A (n=4)	8.98** ± 0.957	1.47 ± 0.0412	29.0 ± 2.04	2.65 ± 0.210	16.8* ± 1.61	198* ± 18.7
B (n=4)	6.80 ± 0.265	0.990 ± 0.0555	37.3 ± 3.68	2.38 ± 0.290	14.5 ± 0.837	385 ± 60.1
a (n=6)	7.80 ± 0.498	1.22 ± 0.0665	39.3 ± 2.64	2.53 ± 0.156	15.8 ± 1.10	327 ± 26.1
b (n=5)	6.46 ± 0.688	1.01 ± 0.0627	29.2 ± 3.73	3.92 ± 0.498	16.1 ± 1.14	289 ± 35.5
A–B	N.S.	p<0.001	N.S.	N.S.	N.S.	p<0.05
A–a	N.S.	p<0.05	p<0.05	N.S.	N.S.	p<0.01
A–b	p<0.05	p<0.001	N.S.	p<0.05	N.S.	p<0.05
B–a	N.S.	p<0.05	N.S.	N.S.	N.S.	N.S.
B–b	N.S.	N.S.	N.S.	p<0.02	N.S.	N.S.
a–b	N.S.	p<0.05	p<0.05	p<0.02	N.S.	N.S.

* ×10⁻³ ** Mean ± SE

ively and the correlation coefficient was 0.89, indicating that the estimation by the method of skinfold thickness was fairly reliable.

Total cholesterol of group (a) was significantly lower than that of group (A). As shown in Table 1, the mean levels of total cholesterol of group (B) and (a) and those of triglyceride of group (B), (a), and (b) were apparently low. On the contrary, group (A) had a normal level of serum cholesterol and triglyceride. Nonesterified fatty acid (NEFA) showed quite normal upon testing in all groups. These results including those of the fat tissue imply that the nutritional state of group (B), (a), and (b) was considerably poor.

The results of T_4 , T_3 , and TSH were quite normal in all 19 subjects examined. Triiodothyronine (T_3) of male (group A and a) was significantly higher than that of female (group B and b). Thyroxine (T_4) also showed the same tendency, in a smaller extent, however. The results may suggest that slightly lowered concentration of serum thyroid hormone partly contributed to the accumulation of fat in the females of the present experiment. Therefore, variation of thyroid hormone even in a physiological range would play a role in the metabolism of fat in young subjects. Thyrotropin (TSH) of group (b) was significantly higher than that of the three other groups, probably reflecting the lowest T_4 . On the other hand, it is well known that monodeiodinated products of T_4 , namely T_3 and rT_3 well reflects the nutritional state. In starvation especially T_3 is lowered while rT_3 , a biologically inactive hormone is increased (Vagenakis *et al*, 1975). In the present experiment no significant change was observed in

T_3/T_4 ratio, whereas rT_3/T_3 ratios of group (B), (a), and (b) which were thought to be in poor nutritional state were significantly higher than that of group (A). Consequently, rT_3/T_3 ratio seems to be a better and more sensitive indicator of a poor nutritional state than T_3/T_4 ratio.

In conclusions: 1) In young Japanese we examined, male had a tendency to obesity whereas female tended to emaciate. 2) Variation of thyroid hormone even in a physiological range might affect the volume of the fat tissue in young people. 3) The fat tissue can be reduced in a relatively short term in young subjects. 4) Reverse T_3 (rT_3) appears to respond to the nutritional state more sensitively than T_3 . And rT_3/T_3 ratio is considered to be a good indicator for detecting slight malnutrition in comparison with T_3/T_4 ratio. *Supported by Grant-in-Aid for Scientific Research # 58340055.

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(Received February 16, 1984)