NOTE

An Evidence for the Decrease of Body Muscle Mass Due to Thyrotoxicosis and Long Term Steroid Therapy by Means of Height, Weight and Upper Arm Circumference Measurements

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Synopsis

A weight-corrected UAC of 109 males and 292 females with untreated thyrotoxicosis was compared with that of the same number of control subjects. Control subjects were chosen from the subjects without apparent diseases; one control for one patient with about the same age, height and weight. The mean value of the weight-corrected UAC in thyrotoxic patients was 25.4 cm both in males and females. The mean value of the controls was 26.7 cm in males and 26.0 cm in females. These findings suggest that UAC of thyrotoxic patients is smaller than that of controls even in the same height and weight, and that there is a significant decrease of body muscle mass in thyrotoxic patients.

Furthermore, it was suggested that the body muscle mass was decreased in 4 cases which had a long term steroid therapy, because the weight-corrected UAC was smaller than that of the controls.

Materials and Methods

The subjects were untreated patients with thyrotoxic diffuse goiter, 109 males and 292 females. The average age of the male patients was 38 years, including 25 cases aged 20–29, 36 aged 30–39, 33 aged 40–49, and 15 aged 50–59. The average age of the female patients was 35 years, including 105 aged 20–29, 96 aged 30–39, 63 aged 40–49 and 28 aged 50–59. Control subjects were chosen from the subjects without thyrotoxicosis and other apparent diseases; one control for one patient with about the same age, height and weight. UAC was measured at right mid-upper arm in a vertical position. As the standard weight is used the heightweight table, reported previously (Matsuki and Yoda, 1972). The weight was expressed as percent deviation from the standard weight.
Results

The correlations between UAC and weight deviation are presented in Figure 1 (male thyrotoxic patients) and Figure 2 (female thyrotoxic patients). The correlation coefficients were 0.78 in the former and 0.94 in the latter. There are both highly significant correlations between UAC and weight deviation. The correlation coefficients and linear regression equations in thyrotoxic patients and controls are presented in Table 1.

In the case of the male thyrotoxic patients

![Graph showing correlation between UAC and weight deviation](image)

**Fig. 1.** The correlation between UAC and weight deviation (male thyrotoxic patients)

**Table 1.** The correlation between UAC and weight deviation

<table>
<thead>
<tr>
<th>Number of cases</th>
<th>Average age</th>
<th>Average height</th>
<th>Average weight</th>
<th>Average weight deviation</th>
<th>Correlation coefficient</th>
<th>Linear regression equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male thyrotoxic patients</td>
<td>109</td>
<td>38</td>
<td>164.2</td>
<td>52.0</td>
<td>-12%</td>
<td>0.78</td>
</tr>
<tr>
<td>Male controls</td>
<td>109</td>
<td>38</td>
<td>164.6</td>
<td>53.5</td>
<td>-10%</td>
<td>0.72</td>
</tr>
<tr>
<td>Female thyrotoxic patients</td>
<td>292</td>
<td>35</td>
<td>153.4</td>
<td>48.0</td>
<td>-8%</td>
<td>0.94</td>
</tr>
<tr>
<td>Female controls</td>
<td>292</td>
<td>34</td>
<td>153.4</td>
<td>48.4</td>
<td>-8%</td>
<td>0.89</td>
</tr>
</tbody>
</table>
The weight-corrected UAC was calculated as follows.

Weight-corrected UAC (cm) = Measured UAC - 0.17W
where W = ± percent weight deviation from the standard

In this manner the weight-corrected UAC was calculated by the linear regression equation. The weight-corrected UAC in various groups are summarized in Table 2. The differences between thyrotoxic patients and controls in males and in females are statistically significant (both p < 0.001). These findings suggest that UAC of thyrotoxic patients is smaller than that of controls even in the same height and weight, and that there is a significant decrease of body muscle mass in thyrotoxic patients. The mean value of the weight-corrected UAC in male thyrotoxic patients was about the same as that in female patients, while the weight-corrected UAC in male controls was larger than that in female controls. This finding suggests that the decrease of body muscle mass in male thyrotoxic patients is more pronounced than that in female patients.

Table 3 shows UAC of patients who have
Table 3. UAC of the patients who received a long term steroid therapy

<table>
<thead>
<tr>
<th>No.</th>
<th>Age</th>
<th>Sex</th>
<th>Underlying disease</th>
<th>Duration of therapy</th>
<th>Height</th>
<th>Weight</th>
<th>Weight deviation</th>
<th>UAC</th>
<th>Weight-corrected UAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>61</td>
<td>male</td>
<td>bronchial asthma</td>
<td>10 years</td>
<td>161</td>
<td>44.5</td>
<td>−22%</td>
<td>18.0</td>
<td>21.7</td>
</tr>
<tr>
<td>2.</td>
<td>52</td>
<td>male</td>
<td>rheumatoid arthritis</td>
<td>6 years</td>
<td>159</td>
<td>47.0</td>
<td>−16%</td>
<td>21.5</td>
<td>24.2</td>
</tr>
<tr>
<td>3.</td>
<td>29</td>
<td>male</td>
<td>nephrotic syndrome</td>
<td>6 months</td>
<td>170</td>
<td>48.6</td>
<td>−23%</td>
<td>20.9</td>
<td>24.8</td>
</tr>
<tr>
<td>4.</td>
<td>17</td>
<td>male</td>
<td>nephrotic syndrome</td>
<td>3 years</td>
<td>165</td>
<td>62.0</td>
<td>+2%</td>
<td>26.0</td>
<td>25.7</td>
</tr>
</tbody>
</table>

received long term steroid therapy. All cases had no edema. The weight-corrected UAC was calculated from the linear regression equation of the male control subjects. A high degree of the decrease of the weight-corrected UAC was found in all patients who had received steroid therapy, being compared with that of the male controls presented in Table 2.

Discussion

There is a significant relationship between UAC and percent weight deviation from the standard, and the linear correlation is obtained by a regression equation. The weight-corrected UAC calculated from the regression equation is a good index for body muscle mass and declines with advancing age (Matsuki and Yoda, 1972).

As presented in Figure 1 (male thyrotoxic patients) and Figure 2 (female thyrotoxic patients), there are in both figures highly significant correlations between UAC and weight deviation. The weight-corrected UAC was calculated from linear regression equations of thyrotoxic patients and controls presented in Table 1. The mean value of the weight-corrected UAC in thyrotoxic patients was 25.4 cm both in males and females. While the mean value of controls was 26.7 cm in males and 26.0 cm in females. From the above results it is found that the body muscle mass is decreased in thyrotoxic patients, especially in males, since the weight-corrected UAC is thought to be a good indicator of body muscle mass.

It is well known that thyroid hormone has a significant effect on skeletal muscles, and that decreased muscle strength and muscle atrophy are common in thyrotoxic patients. In the past, thyrotoxicosis with significant muscle disorders was classified as a specific disease, thyrotoxic myopathy (Zierler, 1951; Whitfield and Hudson, 1961). However, recently it has been reported that myopathy is common in thyrotoxic patients (Millikan and Haines, 1953; Hed et al., 1958; Ramsay, 1966), and Satoyoshi et al. (1963) reported that the skeletal muscles are always more or less impaired in thyrotoxicosis. There have been many reports concerning the abnormal findings of the E.M.G. (Sanderson and Adey, 1952; Havard et al., 1963; Ramsay, 1965), the pathohistological changes of the muscles (Whitfield and Hudson, 1961; Hed et al., 1958; Engel, 1966; Havard et al., 1963), the biochemical findings such as creatine and creatinine metabolism and serum electrolyte (Satoyoshi et al., 1963; Graig and Smith, 1965; Hoch, 1968), and muscle disorders suggested by the decrease of grasping power and dorsal muscular force (Satoyoshi, 1961; Aoki, 1963) in thyrotoxic myopathy, but there are very few reports concerning the changes in the amount of muscle in thyrotoxicosis. Usually, weight loss is due to loss of lean body mass as
well as loss of fat. It was found that the loss of muscle mass plays a larger role in the loss of weight in thyrotoxic patients than in normal subjects by meaning the weight-corrected UAC. The result that the decrease of body muscle mass in male thyrotoxic patients is more pronounced than that in female patients may be related to the fact that there is less muscle in females than males.

As presented in Table 3, the weight-corrected UAC of patients who have received a long term steroid therapy are smaller in each case than that of the male controls shown in Table 2. It is suspected that this may depend on the decrease of body muscle mass due to a long term steroid therapy, although we cannot rule out malnutrition caused by the underlying diseases. It is well known that steroid hormone causes protein catabolism as a physical action. Cushing’s syndrome which is caused by the excessive secretion of steroid hormone, is characterized by the abnormal slenderess of the extremities despite of the trunkal obesity, and this finding may suggest that there is a decrease of the body muscle mass caused by the steroid excess in this syndrome. Although most of the cases shown in Table 3 have their lean body, it may be demonstrated by using the weight-corrected UAC of the cases that the body muscle mass is actually decreased in the cases with the gained weight on steroid therapy.

References