The Relationship between Serum Creatine Phosphokinase Activity and Labor Intensity

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The relationship between serum creatine phosphokinase (CPK) activity and labor strength was examined.

Our epidemiological study showed that the serum CPK activity in a group of men who worked over ten hours was significantly higher than that in the other groups who worked less than ten hours. In women, the serum CPK activity in a group who worked over seven hours was significantly higher than that in the other groups. The serum CPK activity in fishermen was significantly higher than that in those engaged in other than fishery.

In a laboratory study, test subjects were divided into 3 groups to perform 3 types (30%, 50%, 70% of VO2max) of exercise for 6 weeks. A rise in the serum CPK activity was noted in every group during exercise. The mean increase for these groups were 44.0%, 48.1% and 67.9%, respectively.

I INTRODUCTION

Assay for serum creatine phosphokinase (CPK) activity is commonly used in diagnosing the cases of myocardial or skeletal muscle disorder. The interpretation of a significant elevation of serum CPK activity is complicated by physiologic factors that may also produce the same effect. Among these factors are sex, exercise, menstrual cycle and pregnancy.1,2)

There are reports that serum CPK activity in healthy persons is affected by their living and labor conditions, especially long-term muscular labor, the relationship between serum CPK activity and sporting activities was studied.3) We noticed a relationship between serum activity and muscular work.

In this study, we investigated the relationship between serum CPK activity and labor conditions, and evaluated the measurements of serum CPK activity to develop an index of labor intensity.

II METHOD

1. The relationship between serum CPK activity and labor intensity in fishery

   The subjects are 86 healthy adults (32 males and 54 females) aged from 42 to 58 years who are mainly engaged in coastal fishery in Tokushima Prefecture which is located in the Shikoku Island in southwestern Japan. These subjects are all healthy as judged by detailed medical examination. The control group consisted of 52 healthy adults (23 males and 29 females) aged from 40 to 55 years who are mainly engaged in office work or household affairs.

   The subjects were interviewed to obtain information on their labor conditions, and their serum CPK activity were measured.

2. The relationship between serum CPK activity and exercise strength
1) Subject

The subjects are 21 female students from the College for Dieticians. They were divided into group A (8 students), group B (7 students) and group C (6 students).

Selecting suitable subjects, we excluded women with any of the following:
1) Those who were under medical treatment.
2) Those who had a past history of cardiac, muscular or hepatobiliary disease, or who had abnormal subjective symptoms.
3) Those who exhibited abnormalities in routine physical examinations such as measurement of the blood pressure.
4) Those who were engaged in particularly demanding daily physical exercise.

Table 1 shows the ages and physical data on the subjects.

2) Amount of exercise

Table 1 Physical data on subjects

<table>
<thead>
<tr>
<th>Item</th>
<th>A group</th>
<th>B group</th>
<th>C group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Subjects</td>
<td>8</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Sex</td>
<td>female</td>
<td>female</td>
<td>female</td>
</tr>
<tr>
<td>Age (year)</td>
<td>20.3±0.5</td>
<td>20.6±0.7</td>
<td>20.6±0.5</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>156.8±9.2</td>
<td>156.7±5.7</td>
<td>162.3±6.8</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>53.2±10.8</td>
<td>54.7±3.2</td>
<td>56.8±4.0</td>
</tr>
<tr>
<td>Broca index</td>
<td>93.6±12.9</td>
<td>96.4±11.3</td>
<td>91.1±8.6</td>
</tr>
</tbody>
</table>

Broca index: (Weight/(Height-100))×100

For exercise, a bicycle ergometer was used. The amount of exercise corresponded to 30% of the maximum oxygen uptake (VO2 max) for group A, 50% of the VO2 max for group B, and 70% of the VO2 max for group C.

These levels of exercise were carried out for 30 minutes, 3 times a week for 6 weeks.

3. Measurement of serum CPK activity

Venous blood was usually drawn from subjects after 12 hr. of overnight fasting. Serum samples were separated and stored at 4 °C before analyses. Serum CPK activity was determined by a NADPH method with a CPK Test kit (Wako Pure Chemical Industries, Ltd.). Serum GPT activity was determined by a POP·TOOS method.

III RESULTS

1. The relationship between serum CPK activity and labor strength in fishery

Fig. 1 shows the relationship between working hours and serum CPK activity. The longer they worked, the higher serum CPK activity. In men, the serum CPK activity of those who worked over ten hours was significantly higher than that of the other subjects who worked less than ten hours (p<0.05). In women, the serum CPK activity of those who worked over seven hours was significantly higher than that of the other subjects (p<0.05).

Fig. 2 shows a comparison between the serum CPK activity of the fishermen and others. In both men and women, the serum CPK activity of those
engaged in fishery was significantly higher than that of those engaged in other occupations (p < 0.05).

2. The relationship between serum CPK activity and exercise strength

Fig. 3 shows data on the serum CPK activity levels. In all cases the level increased significantly during the experiment. The mean percentage increases over the initial levels in groups A, B and C were 44.0%, 48.1% and 67.9%, respectively.

Fig. 4 shows data on the serum GPT activity levels. In all cases the level increased significantly during the experiment. The mean percentage increases over the initial levels in groups A, B and C were 287.8%, 192.1% and 229.4%, respectively.

IV DISCUSSION

Serum CPK activity would be easy to measure in screening tests. We examined the possible use of the values obtained as health indices by examining the changes in serum CPK levels with daily physical activity. Serum CPK activity was affected by muscular work. For example, serum CPK activity of baseball, football players and other athletes was obviously higher than that of normal workers. The serum CPK activity of normal workers decreased with rest.

In general, the serum enzyme activities, in contrast to tissue enzyme activities, are very low. In pathological conditions such as myocardial infarction and muscular dystrophies, it is believed that organic disturbances result in the destruction of many cells, releasing cellular debris in the serum. In fact many investigators have reported that exercise causes changes in serum enzyme levels. Ikawa explained the physiological mechanism by which the enzyme levels change after heavy exercise as follows: a rise in the intracellular osmotic pressure following ATP consumption, glycolysis, and other physiological processes causes cellular swelling, escape of intracellular enzymes, and eventual rise in the serum enzyme level.

Mandai, et al. compared the serum CPK activity levels in inhabitants of a mountainous region in Kochi Prefecture with those in Suita City residents, Osaka (there was a wide gap in the intensity of the
work these two groups were engaged in) to find the effects of not only the intensity of a specific exercise but also of daily activities. They subsequently found a statistically significant difference between them. The serum CPK activities of the inhabitants of Kochi Prefecture who were believed to be in a much more physically demanding environment were found to be significantly higher than those of the citizens in Suita City. They also stated that it is most probable that serum CPK activity levels may cause changes by long-standing variations in labor conditions.

Kitamura noted that in comparison with that in normal adults, the serum CPK activity level is markedly low in hospitalized patients who are scheduled to be discharged when there is no obvious reason for a diminished serum CPK activity level. He ascribed this difference to the rest the patients could take while being hospitalized. In other words, it is understood that the CPK levels are affected not only by strenuous exercise but also by physical activities.

In this study, serum CPK activity levels in both men and women doing heavy physical work were higher than those in men and women using less physical exertion. Those engaged in fishery were chosen as a heavy physical work group. Among fishermen, the serum CPK level tended to rise to a greater extent as working hours were lengthened, suggesting that the level may be correlated with the quantity muscular work.

Furthermore, exercises with 3 different degrees of intensity—slight (VO2max : 30 %), relatively slight (VO2max : 50 %) and intermediate (VO2max : 70 %)—were incorporated into daily activities. The CPK level increase was statistically significant in each group. In other words, serum CPK activity can be used as an index to indicate the increase in physical activity within a range of daily activities. Therefore by conducting a continuous follow-up study by physical examination (or other similar procedures) on normal individuals, it is possible to measure variations in physical activity.

The data obtained in the present study, revealed that the serum GPT activity level was very low at the start of the experiment but increased markedly, showing an accentuated variation coefficient among the subjects. Therefore, unlike CPK, no correlation between the increase of this enzyme and exercise intensity was noted.

A problem involved in this work is the threshold for liberation of intracellular CPK. Masuda et al. stated that the serum CPK levels showed no elevation when their subjects ran 7 km, but was raised after running 14 km. This difference suggests that physical exertion necessary for usual activity will not affect the results of the present study.

REFERENCES

1) Garcia W. Elevated : Creatine Phosphokinase Levels Associated With Large Muscle Mass. JAMA, 228 : 1395-1396, 1974
血清 CPK 活性値と労働強度の関係について
—労働強度推定を指向した血清 CPK 活性値の評価—

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労働強度と血清 CPK 活性値の関係を評価するために疫学的調査と実験的研究を行なった。まず、
健康な漁村住民について、労働状態と血清 CPK 活性値の関連性を検討した。その結果、労働時間が
長くなるにつれて、血清 CPK 活性値は上昇した。又漁業従事者は他の職業のものに較べて、男女とも
活性値は高かった。

さらに実験的実験において、青年女子21名を被験者を3群に分け、3段階（最大酸素摂取量の30％、
50％、70％）の運動強度の付加運動を1週間に3回、6週間施し、3種の血清酵素活性値の変化
を検討した。その結果、血清 CPK 活性値については、各群とも統計的に有意な上昇を示し、運動負
荷強度が大きくなるに従って、上昇率も大きくなる傾向を示した。

以上より、血清 CPK 活性値を継続的に測定することにより、通常の生活を行なっているものの身
体活動強度を把握することができることが認められた。

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