Training volume, androgen use and serum creatine kinase activity

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Serum creatine kinase (CK) activities were investigated in elite male strength athletes (n = 20) during normal weight training and bodybuilding training (one training session per day), during high volume strength training (two sessions per day) and during strength training (one session per day) with the use of high dose synthetic androgens (five athletes in each subgroup). The findings demonstrated that the increase in serum CK was highest in the subgroup using androgens. These results suggest that strength training with the use of androgenic steroids leads to higher serum CK activities than normal strength training.

Keywords: Androgenic-anabolic steroids, creatine kinase, strength training

Introduction

Serum creatine kinase (CK) increases in proportion to the intensity and duration of the preceding exercise¹. The highest post-exercise serum CK activities are found after very prolonged weight-bearing exercise, such as ultradistance running or triathlon events. Serum CK activities increase very little after non-weight-bearing physical activities such as swimming or cycling which do not include intense eccentric muscular contractions, as reviewed by Noakes². It is probable that the increase in serum CK during training might also be related to the androgenic status of the subjects³. The purpose of this investigation was to study both the effect of strength training volume and the use of androgenic-anabolic steroids on serum CK activities in elite male athletes.

Materials and methods

Twenty elite adult male strength athletes volunteered as subjects for the study and gave their written informed consent. The subjects were experienced strength athletes with a training background of several years. The measurements were carried out both at the beginning and during their normal training season. Prior to the study, all the subjects carried out reduced training for one week including a few days of complete rest from training.

The subjects were divided into four subgroups. Physical details are given in Table 1. Five bodybuilders who had previous experience of the use of anabolic hormones during training comprised the first subgroup (BBNO). They volunteered for the study just before restarting the self-administration of androgenic-anabolic steroids after having refrained from using steroids for a period of three months. The athletes agreed to keep medication diaries which made it possible to monitor the drugs used. Reported mean (±SD) daily doses of the drugs used were as shown in Table 2. Methandienone was generally taken daily.

The intramuscularly self-injected nandrolone and stanozolol were generally used twice per week. Testosterone was self-administered (250 mg/injection, consisting of testosterone-propionate (30 mg); -phenyl-propionate (60 mg); -isocaproate (60 mg) and -decanoate (100 mg) generally two or three times per month.

Because of the simultaneous use of several androgenic-anabolic steroids, the results obtained represent the overall combined effect of the hormones used. Subjects belonging to this subgroup trained for their sports event on average six times per week for 1.5 hours per training session.

Five other bodybuilders comprised the second subgroup (BBNO). They trained on average six times per week.

Table 1. Age, height and weight in the groups studied

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodybuilders¹</td>
<td>26±4</td>
<td>181±6</td>
<td>90±9</td>
</tr>
<tr>
<td>Bodybuilders²</td>
<td>29±4</td>
<td>175±5</td>
<td>81±9</td>
</tr>
<tr>
<td>Weightlifters¹</td>
<td>23±2</td>
<td>171±11</td>
<td>77±13</td>
</tr>
<tr>
<td>Weightlifters²</td>
<td>24±3</td>
<td>166±6</td>
<td>70±9</td>
</tr>
</tbody>
</table>

Table 2. Mean daily doses (mg±SD) of testosterone and anabolic steroids in the group of strength athletes (n = 5) self-administering steroids

<table>
<thead>
<tr>
<th>Steroids</th>
<th>n</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>X±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methandienone (p.o.)</td>
<td>4</td>
<td>15</td>
<td>15</td>
<td>—</td>
<td>20</td>
<td>25</td>
<td>19±4.8</td>
</tr>
<tr>
<td>Nandrolone (i.m.)</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>—</td>
<td>22</td>
<td>12±9.1</td>
</tr>
<tr>
<td>Stanozolol (i.m.)</td>
<td>3</td>
<td>10</td>
<td>10</td>
<td>15</td>
<td>—</td>
<td>22</td>
<td>12±9.9</td>
</tr>
<tr>
<td>Testosterone (i.m.)</td>
<td>5</td>
<td>25</td>
<td>25</td>
<td>8</td>
<td>25</td>
<td>25</td>
<td>22±7.6</td>
</tr>
</tbody>
</table>
Training volume, androgens and serum creatine kinase activity: K. Hakkinen and M. Alén

week for 1.5 hours per session. Five weightlifters who trained on average five times per week (1.5 hours/session) comprised the third subgroup (WL\textsubscript{N2}). The fourth subgroup (WL\textsubscript{N2}) consisted of five other weightlifters who trained ten times per week with two sessions each day (1.5 hours/session).

Blood samples were drawn at 9:00 a.m. from the antecubital vein after 35–38 hours of rest and 12 hours of fasting. Serum samples were stored at −70°C. The total activity of serum CK was analysed using reagents of Boehringer Mannheim GmbH (EC 2.7.3.2) at 37°C. The analyses were carried out according to the instructions of the manufacturer.

The statistical significance of the differences between and within the subgroups was analysed firstly with the help of ANOVA analysis. On the basis of these analyses the significant effects and interactions were further localized with the help of paired and unpaired Student’s t-test (two-tailed).

Results and discussion

No significant differences were noticed in the activities of serum CK between the groups at the beginning of the investigation. The serum CK increased in each group during training (Table 3). The increase in CK activities was greatest in group BB\textsubscript{AN} and lowest in group BB\textsubscript{NO}.

Because daily training produces persistently elevated serum CK levels, the initial measurements had to be timed for the beginning of their training season. It was interesting that in spite of this procedure, the base values were higher than reported for non-athletes.

It is documented that serum CK peaks one to two days after exercise or even later\textsuperscript{1,3,4}. In the present study blood samples were taken between 35 and 38 hours after the final training session. Because of the limited numbers of blood samples taken, the present data need careful interpretation. It is possible that the serum CK values obtained might not represent the highest values reached by the experimental conditions reported here.

Table 3. Serum activities of creatine kinase (IU) before and after strength training in the group studied

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Before</th>
<th>After</th>
<th>Differences (P1)</th>
<th>Differences (P2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bodybuilders\textsubscript{AN}</td>
<td>5</td>
<td>231±66</td>
<td>1850±709</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Bodybuilders\textsubscript{NO}</td>
<td>5</td>
<td>170±75</td>
<td>256±104</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Weightlifters\textsubscript{N1}</td>
<td>5</td>
<td>157±44</td>
<td>404±96</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Weightlifters\textsubscript{N2}</td>
<td>5</td>
<td>119±44</td>
<td>392±174</td>
<td>**</td>
<td>**</td>
</tr>
</tbody>
</table>

It has been suggested that eccentric muscle contractions are one of the main reasons for the elevation in serum CK with exercise and training\textsuperscript{5}. Weightlifting and bodybuilding training involves all types of muscle contractions. The relative loads reflecting in part the intensity of strength training are known to be greater in weightlifters than in bodybuilders. This might explain in part the slightly greater increase found in serum CK among the weightlifters in this study. However, the volume of training had only a minor influence on the increase in serum CK (Table 3).

It has been proposed that athletes using androgens might be able to carry out greater volume and/or intensity of training\textsuperscript{6} which would lead to higher levels of serum CK\textsuperscript{6}. The present observations (Table 3) indicate that the difference in the training volume between the non-users and users might not be a plausible explanation for the difference observed in serum CK levels. Although the individual training sessions may differ with regard to the recovery periods between the repetitions, it also seems unlikely that the overall training intensity explains the differences found in CK levels between the athletes using androgens and the other athletes.

The experimental conditions suggest that the increased leakage of CK in the subgroup of BB\textsubscript{AN} might not result from intensified contractile activity or by increased passive mechanical forces but it might be related to the excess of androgens. The present results are in agreement with previous observations which showed that an anabolic-steroid induced hyperandrogenic state during strength training was associated with greater serum aspartate aminotransferase (the more ‘liver specific’ gamma-glutamyltransferase was not elevated) in comparison with that taking place during normal strength training\textsuperscript{2,7}.

Although the present experimental design had limitations, one might suggest that during strength training the use of androgenic-anabolic steroids leads to higher serum CK levels in comparison with changes taking place during normal strength training.

References

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K Häkkinen and M Alén

doi: 10.1136/bjsm.23.3.188

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