COMPARISON OF THE EFFECTS OF ACTIVE AND PASSIVE RECOVERY AFTER INCREMENTAL EXERCISE TO EXHAUSTION ON SERUM TESTOSTERONE AND PROGESTERONE LEVELS OF ATHLETES

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Abstract

Introduction: The aim of the present study was to compare the effects of active and passive recovery after a very heavy exercise session (incremental exercise to exhaustion) on serum testosterone and progesterone levels of athletes. Materials and Methods: A total of 26 healthy, active sprinters participated voluntarily in the study. Exclusion factors included endocrine, cardiac diseases and diabetes. Blood samples were drawn at three stages: baseline, immediately after an excessively heavy workout and 10 minutes after recovery on an empty stomach. Variance analysis was the statistical test used. A P_value < 0.05 was considered significant and SPSS 18 software program was used for entering the data in the computer. Findings: The results showed that passive recovery results in more reduction of testosterone and progesterone levels as compared to active recovery, but this difference is not significant (P > 0.05). Conclusion: It can be concluded that type of recovery and post recovery period has no effect on testosterone and progesterone serum levels of athletes.

Key words: recovery, active, passive, exercise, exhaustion, testosterone, progesterone

Introduction

One of the problems faced by athletes, especially during competition and training is return to initial levels before training or competition. This period is defined as the time required to return to the initial metabolic state. During this period, various metabolic processes take place in order to replenish the lost energy and storage. These processes are as important as the processes involved during exercise and work. Incomplete recovery processes between training sessions or competition results in an increased tiredness and reduction in ability to perform further activities. In general there are two types of recovery; passive recovery and active recovery. Active recovery is generally considered to be a bit of light practice session after heavy training or competition and it is believed that it improves recovery (Flier, 2004).

The increase in cardiac output due to passive recovery is relatively less than that due to active recovery and lesser involvement of muscles results in a lower number of messages from mechanical receptors and central orders (Karkoulias, et al., 2008). Active recovery results in more lactate uptake as compared to passive recovery (Hammes, 2003). Also, light active recovery after heavy exercise maintains adrenergic activity and catecholamine concentration (Wigernaes, et al., 2000). The testosterone that is secreted by Leydig cells present in the testes is necessary for the growth and division of fertility cells involved in sperm production (Gupta, et al., 1996). Approximately 97% of the testosterone after secretion from the testes loosely attaches with plasma albumin or more strongly with sex hormone binding globulin. It remains in blood circulation for about half to one hour. The testosterone remains in tissues or is converted into an inactive form to be excreted later on (Gupta, et al., 1996). Tokmakidis and coworkers showed that testosterone hormone levels do not increase (Gupta, et al., 1996) or alter (Declan, et al., 2003) after a training session. Certain studies have shown that testosterone levels increase after cessation of training (Fairchild, et al., 2003) while others have reported no change in levels (Declan, et al., 2003; Crisafulli, et al., 2003; Wigernaes, et al., 2001). Progesterone is one of the steroidal hormones whose large quantities can strengthen re-absorption of sodium, chloride and water from the renal distal tubules like estrogens, testosterone and supra renal adrenal hormones. But the extraordinary fact is that progesterone causes excretion of water and sodium most of the time that is due to competition between progesterone and aldosterone as they have common protein receptors for attachment that causes the transfer of sodium ions from the epithelial tubular cells. When progesterone attaches to these receptors, aldosterone cannot attach to them. Thus, though progesterone it can result in mild increase in the re-absorption of sodium and water in the renal tubules, it antagonizes aldosterone strongly thus resulting in excretion of sodium and water from the body. It is proposed that measurement of testosterone and progesterone levels can be one of the important characteristics determining physiological pressure due to training (Fairchild, et al., 2003). Decreased levels of testosterone and progesterone are signs of increased catabolic processes.
Similarly, if this decrease is more than 30%, it is one of the important signs of Excessive Exercise Syndrome and in between is the point that the recovery period after training is incomplete (Schwane, et al., 1983). Considering the fact that the role of recovery after training has been studied in most of the studies but the relation between recovery, testosterone and progesterone has not been paid due attention to date, the authors decided to study the changes in testosterone and progesterone levels after passive and active recovery in athletes undergoing a very heavy exercise session (Bruce Max. Test).

**Materials and Methods**

This was a semi-experimental study with one session of Bruce Maximum test on two different occasions (days) and included 26 sprinters of the city of Isfahan who voluntarily enrolled in the study. They were divided into two groups; active recovery group (12 athletes) and passive recovery group (14 athletes). After a thorough explanation about the study and test, the consent form and questionnaire comprising of general characteristics and history of medical problems was filled. They were also asked to adhere to a normal sleep pattern (at least 8 hours sleep), day to day activities and diet during the study and abstain from strenuous bodily activity, diet supplements, drugs, coffee, cigarettes and cocoa from at least 48 hours before the test until the time of blood sample collection.

The results of the study were confidential and the reports were given to the athletes after the study. The limitations of the study were lack of control over the impulse of the population under study and also their unreported hidden medical problems. The study programs included warm up 10 minutes, Bruce Test 10 minutes and either active or passive recovery. Venous blood samples (5 ml) were drawn by two specialists (one expert and one physician) after 12 hours fasting between 7.30 A.M and 11 A.M to determine the testosterone and progesterone levels. First sample was drawn 30 minutes before start of test in the resting state, second sample immediately after Bruce Test and third sample 10 minutes after recovery.

It is worth mentioning that in order to prevent cell lysis, a German made Hettich refrigerated centrifuge with the specification of 3000 rounds per minute at 4 degrees centigrade was used for 10 minutes to separate the cells at the site and the samples were transferred on dry ice to the laboratory to be stored at -70 degrees centigrade for further analysis. The progesterone and testosterone levels were determined by DIALPLUS kit (made in U.S.A). One sided Variance analysis was the statistical test used and SPSS 18 software program was used for entering the data in the computer. A confidence level of 95% was considered for all of the samples.

**Results**

The results showed that none of the main effects (stages and type of recovery program) affected testosterone secretion significantly. According to the analyses, the changes in mean testosterone secretion levels in both groups were not statistically significant. The mean testosterone levels during various stages in the two groups are presented in table no.1. As shown in table 1, there was no significant difference in testosterone levels during various stages in both the active and passive recovery group. The mean progesterone levels in both the groups were higher after recovery as compared to the other stages (before and after heavy strenuous exercise). The mean progesterone levels during various stages are presented in table no.2. As shown in table no.2, there was no significant difference in progesterone levels during various stages in both the active and passive recovery group. Serum testosterone concentration (unit per litre).

Table 1. Mean, S.D., and testosterone level of blood in active and passive recovery group in 3 stages(unit per litre)

<table>
<thead>
<tr>
<th>Stages</th>
<th>Recovery</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before incremental exercise to</td>
<td>Passive</td>
<td>10.60</td>
<td>1.25</td>
<td>14</td>
</tr>
<tr>
<td>exhaustion</td>
<td>Active</td>
<td>9.89</td>
<td>2.02</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10.27</td>
<td>1.68</td>
<td>26</td>
</tr>
<tr>
<td>After incremental exercise to</td>
<td>Passive</td>
<td>10.62</td>
<td>2.81</td>
<td>14</td>
</tr>
<tr>
<td>exhaustion</td>
<td>Active</td>
<td>10.74</td>
<td>2.24</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10.68</td>
<td>2.51</td>
<td>26</td>
</tr>
<tr>
<td>After 10 minutes of recovery</td>
<td>Passive</td>
<td>10.64</td>
<td>2.57</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td>10.42</td>
<td>2.72</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10.54</td>
<td>2.59</td>
<td>26</td>
</tr>
</tbody>
</table>

![Figure 1](image_url)  
**Figure 1.** Mean on serum testosterone level in passive and active recovery group (before, just after, and 10 minutes after recovery)

Table 2. Mean, S.D., and progesterone level of blood in active and passive recovery group in 3 stages(unit per litre)

<table>
<thead>
<tr>
<th>Stages</th>
<th>Recovery</th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before incremental exercise to</td>
<td>Passive</td>
<td>.61</td>
<td>.41</td>
<td>14</td>
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<tr>
<td>exhaustion</td>
<td>Active</td>
<td>.63</td>
<td>.37</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>.62</td>
<td>.38</td>
<td>26</td>
</tr>
<tr>
<td>After incremental exercise to</td>
<td>Passive</td>
<td>.99</td>
<td>.53</td>
<td>14</td>
</tr>
<tr>
<td>exhaustion</td>
<td>Active</td>
<td>.70</td>
<td>.42</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>.85</td>
<td>.49</td>
<td>26</td>
</tr>
<tr>
<td>After 10 minutes of recovery</td>
<td>Passive</td>
<td>1.08</td>
<td>.44</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Active</td>
<td>.94</td>
<td>.43</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1.02</td>
<td>.43</td>
<td>26</td>
</tr>
</tbody>
</table>
Discussion

The results of the present study showed that physical training (incremental exercise to exhaustion) has no significant effect on serum testosterone levels in athletes, but there can be an increase in progesterone levels. Also, passive recovery results in a greater decrease in testosterone and progesterone levels as compared to active recovery, but this difference is not significant. On the basis of previous studies that show that a session of exercise to exhaustion level results in increased levels of certain hormones like prolactin, cortisol and ACTH, while concentration of testosterone decreases (Carli, et al., 1992; Fotherby & Pal, 1985; Calbo, 1984; Kramer, 1988; Martelli, et al., 1987). Also, according to certain studies it is possible that testosterone concentration might increase after a training session, but its concentration decreases after 30 minutes such that it is lower than the pre exercise training levels (Freeman, et al, 2004; Tremblay, et al., 2004; Smallridge, et al., 1985). In the study by Karkoulias and coworkers in 2008 that compared a group of marathon runners who had been educated and middle aged amateur athletes, testosterone levels decreased and returned to normal levels one week after the competition (Karkoulias, et al., 2008). On the basis of a report by Keizer and coworkers after evaluation of testosterone response after weight lifting competition, it was concluded that testosterone concentration does not change significantly after competition (Keizer, et al., 1989). In the study by Semple and coworkers on marathon runners it was determined that testosterone levels decreased significantly (Semple, et al., 2001). In the study by Jurimae and coworkers regarding hormonal changes in male rowing athletes, the testosterone concentration immediately after rowing was related to the distance covered by the rowers such that there was no change in testosterone concentration during the initial two hours but the levels decreased after two hours (Jurimae, et al., 2001). In another study by Houmard and coworkers in 1990, the testosterone levels of long distance runners were evaluated and it was observed that testosterone levels did not alter after a quiet training session and there was no change up to 4 weeks after running (Houmard, et al., 1990). In another study by Safarinejad and coworkers, the effect of severe and long distance running on testosterone levels was studied wherein the testosterone levels were lesser in those athletes who ran with more intensity (Safarinejad, et al., 2009). In the study by Keizer and coworkers, testosterone level changes were studied in athletes preparing for marathon. The levels were high even 2 days after the competition. The decrease in testosterone concentration is related to the distance covered by the athlete and can return to normal levels after rest (Keizer, et al., 1989). Tremblay and coworkers showed that testosterone hormone levels increase in response to exercise in athletes undergoing various training scenarios.

This increase was more in those exercising to the resistance level as compared to those exercising to the tiredness level. After an initial increase in testosterone concentration, there was a specific reduction in concentration level during rest that was related to the type and intensity of training. The increased levels were sustained even during rest in those exercising to the resistance level, while these changes were less in those trainings to the tiredness level (Tremblay, et al., 2005). In the study by Kraemer WJ., and Ratamess NA in 2005, the effect of the time period of exercise training on steroidal hormonal response in training men was studied. The testosterone levels increased one hour, 80 and 120 minutes after running and decreased 3 hours after rest. It was determined that more than 80 minutes of running is required to stimulate testosterone secretion. Maximum increase was 120 minutes after running. Therefore, time period and intensity of exercise have an effect on hormonal response (Kraemer & Ratamess, 2005). The results of the present study are not in line with the above mentioned study. In the present study, there was no significant change in serum testosterone levels during various training stages. Buten et al., (1982) in a group study comparing young swimmers with a control group observed that progesterone level changes occurred on the 21st day. The results showed that progesterone levels were lower in the luteal stage swimmers as compared to the control group (Jurkowski, 1982). As the serum testosterone and progesterone levels did not change significantly after 10 minutes of active and passive recovery, it is proposed that more time should be allocated for recovery after training.

Conclusion

The results of the present study showed that passive recovery is responsible for a greater decrease in testosterone and progesterone levels after training as compared to active recovery, but this decrease is not significant (P > 0.05). Therefore, type of recovery and post recovery period has no effect on testosterone and progesterone levels of athlete.
References


USPOREDBA UČINAKA AKTIVNOG I PASIVNOG OPORAVKA NAKON STUPNJEVITOG OPTEREĆIVANJA DO ISCRPLJENJA NA SERUM TESTOSTERONA I PROGESTERONA U KRVI SPORTAŠA

Sažetak
Uvod: Cilj ovog istraživanja bio je usporediti učinke aktivnog i pasivnog oporavka nakon vrlo teškog vježbanja (stupnjevito opterećivanje do iscrpljenja) na serum testosterona i progesterona u krvi sportaša. Materijal i metode: Ukupno je 26 zdravih, aktivnih sprintera sudjelovalo dobrovoljno u studiji. Isključenje za studiju su bili čimbenici koji uključuju endokrinološke bolesti, srčane bolesti i dijabetes. Uzorci krvi su izvučeni u tri faze, u mirovanju, odmah nakon pretjerano teških treninga i 10 minuta nakon oporavka (natašte). Za obradu je korištena Analiza varijance (SPSS-18 softver) a p vrijednost < 0,05 smatranje je značajnom. Nalaz: Rezultati su pokazali da pasivni oporavak pokazuje smanjenje razina testosterona i progesterona u usporedbi s aktivnim oporavkom, ali ta razlika nije značajna (P > 0,05). Zaključak: Može se zaključiti da vrsta oporavka i post-oporavka nema nikakvog utjecaja na razinu testosterona i progesterona u serumu sportaša.

Ključne riječi: oporavak, aktivno, pasivno, vježbanje, iscrpljenje, testosteron, progesteron