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The effect of various recovery modalities on subsequent performance, in consecutive supramaximal exercise.

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Abstract

Different recovery strategies from maximal exercise seem to induce different lactate utilization patterns without significantly affecting performance on one subsequent maximal exercise. It remains unclear however, how varying recovery modalities affects repeated maximal exercise. To study this, we examined in 16 subjects, the influence of passive (P), active leg (L) and active arm (A) twenty minutes recovery periods separating a series of four exhaustive exercises, up to two minutes duration. Significant decreases in performance between the first and fourth exercise were observed in all recovery series but a significant decrease in performance in the second exercise was observed during passive recovery alone ($p < 0.01$). When the different types of recovery are compared, a more pronounced decrement in performance was found during passive recovery when first and last exercises are compared ($p < 0.04$). Pedaling duration in each successive exercise was unaffected in A or L but was significantly shorter in P ($p < 0.03$). Highly significant differences in mean blood lactate kinetics were found for the three recovery patterns used, with more elevated peak and nadir levels in passive recovery, intermediate values in active arm and lowest concentrations in active leg recovery. However, no correlation was found between performance and lactate concentration at the onset of exercise ($r = -0.15$; $p = NS$). Mean heart rates were similar throughout the experimental protocol except for a lower cardiac frequency during the last 5 minutes of passive recovery ($p < 0.01$). Blood hematocrits showed higher hemoconcentrations in repeated exercise during passive recovery ($p < 0.01$) despite significantly lower total fluid losses in this group. A significant correlation between peak hematocrit and blood lactate was also found ($r = 0.67$; $p < 0.001$). We conclude that the type of recovery has a significant effect on blood lactate elimination kinetics, and active recovery is beneficial in the preservation of performance during repeated maximal exercise. Furthermore, plasma shifts across the extra and intravascular spaces are induced by maximal exercise, and appear to closely follow blood lactate kinetics

Comparative study of lactate removal in short term massage of extremities, active recovery and a passive recovery period after supramaximal exercise sessions

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Résumé / Abstract

This investigation highlights the comparison of blood lactate removal during the period of recovery in which the subjects were required to sit down as a passive rest period, followed by active recovery at 30 % VO_2max and short term body massage, as the three modes of recovery used. Ten male athletes participated in the study. Exercise was performed on a bicycle ergometer with loads at 150 % VO_2max, each session lasting 1 min, interspaced with 15 sec rest periods, until exhaustion. Blood lactate concentration was recorded at recovery periods of 0, 3, 5, 10, 20, 30, and 40 min, while VO_2, VCO_2 and heart rate were recorded every 30 sec for 30 min. The highest mean lactate value was found after 3 min of recovery irrespective of the type of modality applied. Significantly lower half life of lactate was observed during active recovery (15.7±2.5 min) period, while short term massage as a means of recovery required 21.8±3.5 min and did not show any significant difference from a passive type of sitting recovery period of 21.5±2.8 min. Analysis of lactate values indicated no remarkable difference between massage and a passive type of sitting recovery period. It was observed that in short term massage recovery, more oxygen was consumed as compared to a passive type of sitting recovery. It is concluded from the study that the short term body massage is ineffective in enhancing the lactate removal and that an active type of recovery is the best modality for enhancing lactate removal after exercise.

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Effect of active versus passive recovery on metabolism and performance during subsequent exercise.

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Abstract

This study tested the hypothesis that active recovery between bouts of intense aerobic exercise would lead to better maintenance of exercise performance in the second bout of exercise. Seven trained men on 2 separate occasions (VO(2peak) = 58.3+/- 9.4 ml x kg(-1) x min(-1)) performed as much work as possible during two 20-min cycling exercise bouts, separated by a 15-min recovery period. During passive recovery (PR), subjects rested supine, while during active recovery (AR) subjects continued to cycle at 40% VO(2peak). Muscle biopsies and blood samples were obtained. Neither muscle glycogen or lactate was different when comparing AR with PR at any point. In contrast, plasma lactate concentration was higher (p<.05) in PR versus AR during the recovery period, such that subjects commenced the second bout of intense exercise with a lower (p <.05) plasma lactate concentration in AR (4.4 +/- 0.7 vs. 7.7 +/- 1.4 mmol. L(-1) following AR and PR, respectively). Work performed in Bout 2 was less than that performed in Bout 1 in both trials (p<.01), with no difference in work performed between trials. These data do not support the benefit of AR when compared to PR in the maintenance of subsequent intense aerobic exercise performance.

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The effects of compression garments on recovery of muscle performance following high-intensity sprint and plyometric exercise.

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Abstract

This study compared the effects of compression garments on recovery of evoked and voluntary performance following fatiguing exercise. Eleven participants performed 2 sessions separated by 7 days, with and without lower-body compression garments during and 24h post-exercise. Participants performed a 10-min exercise protocol of a 20-m sprint and 10 plyometric bounds every minute. Before, following, 2h and 24h post-exercise, evoked twitch properties of the knee extensors, peak concentric knee extension and flexion force were assessed, with blood samples drawn to measure lactate [La(-)], pH, creatine kinase (CK), aspartate transaminase (AST) and c-reactive protein (C-RP). Heart rate, exertion (RPE) and muscle soreness (MS) measures were obtained pre- and post-exercise. No differences (P=0.50-0.80) and small effect sizes (d<0.3) were present for 20-m sprint (3.59+/-0.22 vs. 3.59+/-0.18s) or bounding performance (17.13+/-1.4 vs. 17.21+/-1.7 m) in garment and control conditions. The decline and recovery in concentric force were not different (P=0.40) between conditions. Full recovery of voluntary performance was observed 2h post-exercise, however, evoked twitch properties remained suppressed 2h post-exercise in both conditions. No differences (P=0.40-0.80, d<0.3) were present between conditions for heart rate, RPE, [La(-)], pH, CK or C-RP. However, 24h post-exercise a smaller change (P=0.08; d=2.5) in AST (23.1+/-3.1 vs. 26.0+/-4.0) and reduced (P=0.01; d=1.1) MS (2.8+/-1.2 vs. 4.5+/-1.4) were present in the garments. In conclusion the effects of compression garments on voluntary performance and recovery were minimal; however, reduced levels of perceived MS were reported following recovery in the garments.

THE EFFECTS OF CONTINUOUS COMPRESSION AS A THERAPEUTIC INTERVENTION ON DELAYED ONSET MUSCLE SORENESS FOLLOWING ECCENTRIC EXERCISE

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It has been established that exercise-induced muscle damage occurs following exercise in individuals who are not accustomed to rigorous physical activity. The damage results in a dull aching pain, known as delayed onset muscle soreness (DOMS). Other clinical signs associated with DOMS include a decreased range of motion, swelling, and strength loss; all of which can lead to an impaired ability to perform daily activities. **PURPOSE:** The purpose of this study was to determine the effect of a continuous compression treatment protocol on the clinical signs and pain associated with DOMS. **METHODS:** Twenty male subjects, aged 18-35, were randomly assigned to a continuous compression treatment protocol (CC) or a no treatment protocol (N). The induction of DOMS was accomplished by having the subjects perform repetitive eccentric contractions of the quadriceps muscle group. Subjects completed three sets of knee extension repetitions. Immediately following the eccentric contractions, subjects in the (CC) group applied a compression garment over the involved thigh. The (CC) subjects wore the compression garment continuously during the 3-day recovery period. The subjects in the control group did not receive any treatment. All subjects reported at 24, 48, and 72-hour post exercise for measurement of the dependent variables of passive muscle soreness, active muscle pain, rating of perceived exertion associated with the active muscle, swelling, extension and flexion angles, and strength measures. **RESULTS:** The primary findings of this investigation were that continuous compression resulted in a significant difference in the overall perception of passive muscle soreness across time at 24 and 48-hours post exercise ($F(3, 54) = 3.75$, $p < 0.05$). In addition, regardless of treatment protocol, there were significant differences across time observed ($p < 0.05$) in active muscle pain, rating of perceived exertion associated with the active muscle, distal thigh circumference, supine knee flexion angle, and knee extension angle following the induction of DOMS. **CONCLUSIONS:** Results suggest that continuous compression is beneficial in reducing muscle soreness during the first 48-hours after unaccustomed eccentric exercise. By providing mechanical support to the tissues, a compression garment may decrease the detrimental effects associated with DOMS.

Effects of active recovery on various physiological systems vs. passive recovery in respect to both endurance and anaerobic exercise.

While the common wisdom from locker room coaches is that a cool down period after running is beneficial and helps reduce soreness, there has been little scientific evidence presented by these "trainers" that show what exactly active recovers (AR) does, how it helps (or hinders) recovery and performance, and when it should be used. AR is fundamentally different from passive recovery (PR) in its approach. While PR would be considered sitting, lying prone or supine, or even just standing, AR is usually light jogging or walking, or bicycling; upper body AR is sometimes used, especially if the initial fatiguing exercise involves mostly or entirely upper body muscles.

The effect of AR on lactate has been well documented. The overwhelming results of the studies were that in both aerobic or endurance exercises[2, 4, 6, 12,18,] and maximal or anaerobic exercises[12, 19, 22,] some form of active recovery showed significant benefits in lactate removal. However, the effect of lactate removal itself is questionable as to whether it actually has performance benefits. Studies have shown that high levels of lactate did not have significant effect on maximum effort performance1, or on series of exhaustive exercises[22]. Given the limited number of studies that actually measured performance in relation to lactate levels, it cannot yet be said that AR plays no role in performance. Quite to the contrary, despite the evidence that lactate removal may not play an important role, numerous studies have shown performance increases due to AR. Performance increases in successive endurance[4, 6,] power[7, 10, 19,] exhaustive exercises[22], and sports exerices[9] show that AR does play a significant role in performance. These findings could be due to the fact that while reduction in the lactase molecule itself may not increase performance, a normalization of pH through lactate buffering and removal may be the missing factor influencing performance. A normalization in pH during AR has been shown in several studies[15, 17, 21] to be superior in its effect than PR.

AR has many other benefits over PR besides performance enhancement. A decrease in the post-exercise Free Fatty Acid (FFA) rise has been observed[5, 20]. This could be due, in part, to the continued use of FFA for fuel during the AR. White Blood Cell (WBC) counts are normally lowered during PA after exercise, and AR has been shown to reduce that drop[3, 20]. Several cardio-pulmonary benefits have been observed as well. Heart rate reduction and venous return from muscles[11] are improved with AR. AR was also shown to not interfere with pulmonary gas kinetics[14] after exercise. Skin blood flow, sweat rate, and thermoregulation have all been suggested to increase in effectiveness through non-thermoregulatory mechanisms during AR over similar workloads and periods of recovery time as PR[16].

While all of the previously mentioned effects are quite beneficial to sports and fitness, some effects of AR are a double-edged sword, depending on the kind of training you perform. Muscle glycogen shows a decrease with AR as opposed to PR in some studies[10, 13]. Both of the studies used short high intensity exercises. For distance runners, sports athletes and individuals exercising for fitness, this may not outweigh the benefits of AR, but those individuals looking to add muscle mass would find a negative effect from decreased glycogen levels. A continued suppression of insulin, perhaps in part due to glycogen reduction, has also been observed during AR recovery[20]. This decreased insulin would have detrimental effects on muscle breakdown/synthesis.

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