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Effect of resistance exercise with arm sleeve compression garments accelerates blood lactate removal

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ABSTRACT
Background: It has long been suggested that arm sleeve compression garments (CG) may impact blood lactate levels ([Lac-]^B) during the recovery from resistive exercise. **Objective:** In this study, we tested the hypothesis that upper-body CG during recovery from intense resistive exercise contribute to La clearance, thus leading to reduced [Lac-]B. **Methods:** Sixteen healthy men underwent two sequences of flexion and extension exercises of the elbows and triceps on a pulley, with and without upper-body CG, separated by 72h. The exercises were performed with 3 sets of 10 RM, and a cadence of 2 sec was maintained in the eccentric phase and concentric phase. During an inactive recovery period of 20 minutes, serial arterialized venous blood samples were collected to obtain lactate concentrations. **Results:** Subjects showed similar responses at baseline and at peak exercise during the two experimental conditions. [Lac-]B during recovery was reduced with the use of upper-body CG at 5, 10, 15, and 20 min of recovery (P<0.05). **Conclusion:** These data are consistent with the notion that CG can accelerate lactate removal during recovery from intense exercise.
Keywords: Lactate metabolism; Arm sleeve compression garments; Exercise.

BACKGROUND

During recovery from intense exercise, the blood lactate concentration ([Lac-]^B) decreases more rapidly when light to moderate exercise is performed.(1, 2) In fact, during active recovery at 30-70% of peak oxygen uptake, lactate is used as a substrate for oxidative metabolism, thus increasing the rate of lactate removal from the circulatory system.(1,3) Furthermore, the rate of [Lac-]^B decline may be further influenced by training status, as demonstrated by the higher rates of La removal in endurance-trained individuals.(4)

It has also been suggested that the use of arm sleeve compression garments (CG) may promote strength recovery(5,6) and affect [Lac-]^B levels after exercise. Studies have demonstrated that after exercising with compression garments, [Lac-]^B is lower,(7) which could contribute to improvement in the muscles' ability to perform subsequent exercises.

However, there is no significant evidence that CG use can accelerate exercise recovery and alter La removal. Therefore, the aim of the present study was to test the hypothesis that the use of CG during high-intensity resistance exercise contributes to greater clearance of La, leading to a reduction in [Lac-]^B when compared to recovery without the use of CG.

METHODS

Subjects

Sixteen men (mean 26.08 ± 3.92 yr; height, 175.7 ± 2.4 cm; body mass, 93.7 ± 10.6 kg; body mass index, 29.23 ± 2.12 kg.m^{-1}) participated in this study. All subjects were physically active and had several years of experience performing strenuous resistance training. Inclusion criteria for the selection of subjects were > 2 years of experience in strenuous resistance training and a history of non-smoking. Subjects were informed about the purpose of the study and experimental procedures, and all provided an informed consent form. The study was approved by the Ethics Committee of the Faculty of Education and Health Sciences of the University Center of Brasília – UniCEUB and approved: CAAE 57466516.4.0000.0023.

Experimental design

Subjects visited the laboratory three times during the experimental period. On the first visit, the one-repetition maximum (1RM) for eight exercises was measured for each subject to determine the weights to be used for each exercise on the experimental days (amount of time required, 60 min). On the second and third visits, the subjects performed experimental tests

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with the use of CG or without the use of CG (Control, CON) during the recovery period after the performance of resistance exercise (time required for resistance exercise, 60 min).

The CG and CON assays were conducted in a random order with a 72h interval. Immediately after completing the resistance exercise in each trial, the CG test subjects switched to a full-body CG. Microfiber-3 compression sleeves (Model Second Skin, Brazil) were used in this study. Compression garments were applied with maximum pressure around the arm (maximum pressure of 22 and 12 mmHg in the biceps). The size used depended on the circumferences of the subjects' forearms and arms. The size of the CG for each subject was chosen based on the instruction manual and involved the measurement of arm circumferences. The subjects wore the prescribed clothes throughout the protocol period.

Strenuous resistance exercise

On each experimental test day (CG or CON), the subjects performed a warm-up series comprising 15 repetitions at 50% of 1RM and stretching of the main muscle groups targeted by the exercises. After these warm-up exercises, measurements of upper-limb muscle strength (1RM), determination of subjective muscle pain and circumferences, and resting blood samples were taken to determine baseline values. After completing these baseline measurements, subjects began the resistance exercises, which comprised six exercises for the upper body muscles (chest bench press, side bend, seated row, shoulder lift, barbell curl, and triceps down). Each set of exercises comprised 10 repetitions involving three sets for each exercise. The intensity of all exercises was set at 70% of 1RM. Subjects rested for 90 s between sets and exercises and immediately after each maximal exercise, they were asked to provide a rating of their perceived exertion (RPE) using the Borg scale.(8)

Recovery time, blood sampling and analyses

The recovery time was performed immediately after the end of the exercise, with the participants remaining seated for 20 min, without the use of active recovery and without the use of arm sleeve compression. Blood collections of 20μL per sample were obtained from the tip of the index finger of the dominant side, 10 s before the end of the exercise and during exercise recovery at the time intervals of 5-, 10-, 15-, and 20-min. Analysis of the lactate concentration was performed using a lactimeter (Accutrend Lactate, Roche).

Measurements of circumference

The circumferences of the midpoints of the arms were measured with a measuring tape before the resistance exercises. Each measurement was performed twice by the same investigator, and the mean value of the two measurements was adopted.

Statistical analysis

Data are expressed as mean ± SD. Changes in blood parameters over time were initially compared using two-way ANOVA with repeated measures. When the ANOVA revealed a significant interaction or main effect, the Tukey–Kramer test was performed for post hoc analyses. The subjective feeling of muscle soreness was compared using a paired t-test. For all tests, $P < 0.05$ was statistically significant.

RESULTS

Sixteen subjects were recruited for this study, and no subjects were excluded. No significant differences were found between the groups regarding the variables measured and the age factor exerted no influence. Subjects weighed 93.7 ± 10.6 Kg, height 1.79 ± 0.05 m, body mass index 29.23 ± 2.12 kg/m^2, with no differences between right and left arm circumferences (40.58 ± 3.47 vs 40.21 ± 3.32 cm; $P > 0.05$). RPE was not statistically different (8.25 ± 0.45 vs 8.58 ± 0.99; $P > 0.05$). As shown in Figure 1, $[Lac\text{-}]^B$ at 5, 10, 15, and 20 min of recovery was significantly reduced with compression garments. Likewise, the mean area under the curve for [Lac]B was significantly smaller with CG (27.61 ± 7.29 vs 37.78 ± 3.59 [mM].min); $P < 0.05$).

Table 1. Sample characterization

Sample (n = 16)	Values
Body mass, kg	93.7 ± 10.6
Height, m	1.79 ± 0.05
Body mass index, kg/m^2	29.23 ± 2.12
Right arm circumference, cm	40.58 ± 3.47
Left arm circumference, cm	40.21 ± 3.32

*Note: Data presented in mean and SD.

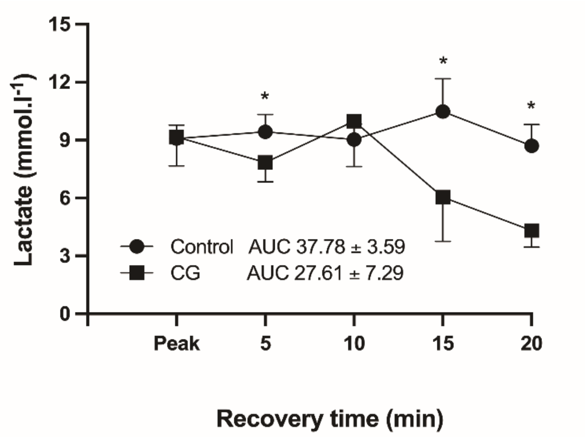

Figure 1. Mean (± SD) blood lactate concentration during peak recovery with CG (filled square) or control (filled circle).

***Note:** ANOVA for repeated measures: group effect $P < 0.05$; time effect $P < 0.05$; interaction $P < 0.05$. *Significantly different by Tukey-Kramer's post hoc procedure. AUC = area under curve.

DISCUSSION

The main finding of this study was that the addition of compression garments during intense exercise decreased [Lac-]B levels during the exercise recovery period in a group of healthy young males. These findings are in accordance with the concept that the use of CG can facilitate the removal of lactate after exercise (9). Our study shows that the blood lactate concentration after high-intensity exercise decreased with compression, with the creation of an inverse gradient due to the retention of lactate in the muscle bed.[9,10]

The removal of lactate after intense exercise depends on four factors: a) fractional uptake by the liver,[11] b) the heart,[12] c) the brain,[13] and d) skeletal muscles.[14] In addition to the dependence of these intrinsic factors, it will also depend on the type of recovery used, active or passive. It is known that when using active recovery, the lactate concentration can be approximately 5-26% lower compared to passive recovery.[15] Thus, in our study, we found a reduction in lactate concentration about 36.83% lower with the use of CG.

However, the pattern of faster decline in blood lactate in our experiments seems to differ from some studies in which light skeletal muscle exercises were performed.[9] In our study, differences are apparent as a function of the type of exercise used. We used strength exercise while other researchers used aerobic exercise.[9]

In the current study, a compressive level considered light was used, although sufficient to influence the venous and lymphatic flow, unlike the arterial system, which would require greater compression to overcome the dilatation of the arterial bed caused by resistance training. This reduction in venous and lymphatic flow, caused by the compression garment, would explain why we observed lower bioavailability of blood lactate after physical exercise, in addition to other circumstances, not observed in our sample, such as metabolization in other regions of the body, for example, by the central nervous system (as an energetic substrate).[16]

Further reflection is needed as to whether or not this can be beneficial, considering that lactate is not only produced in situations of cellular stress (in this case muscle fatigue), but is a product of glycolysis and has several metabolic pathways for its removal to the bloodstream, in addition to signaling between cells. One issue to be considered is that lactate may be directly involved in myogenesis (increase in myogenin expression) contributing to the reduction in myostatin, and thus representing a sign of adaptation to strength training.

Other issues are that it can influence testosterone secretion (increase production) independent of luteinizing hormone (demonstrated in an experimental study) and increases in growth hormone concentration in the face of high lactate levels during resistance training.[17,18]

CONCLUSION

Considering the above information, it is possible that the use of compression stockings during training is not a good alternative in light of cell recovery, but does represent a good solution in competition situations, where the use of compression garments occurs for a short period of time.

Authors' contributions: Conceptualization: WRO, RAED, LTGJ, WAS, IF, VPC, MVSF, RLPS, NSG, AMGC and GRC.Data curation: WRO, RAED, LTGJ, WAS, IF, VPC, MVSF, RLPS, NSG, AMGC and GRC. Formal analysis: WRO, AMGC and GRC. Investigation: William R. Pedon, Renata A. E. Dantas, Adriana M. G. Chiappa, Gaspar R. Chiappa. Methodology: WRO, RAED, LTGJ, WAS, IF, VPC, MVSF, RLPS, NSG, AMGC and GRC.Project administration: WRO, RAED, LTGJ, WAS, IF, VPC, MVSF, RLPS, NSG, AMGC and GRC.

Consent: Informed written consent was obtained from the patient for the publication of this case report. A copy of the written consent is available for review by the Editor of this journal.

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Conflict of interest: Nothing to declare.

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