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Changes in Physiological Stress and Muscle Damage Biomarker Expression after the Completion of Repetitive Cycle Exercises with and without Compression Arm Sleeves

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Abstract: Occupational compression sleeves are commonly used to relieve pain in the upper and lower extremities. Anecdotal data agrees on the benefits of using compression sleeves while performing physical work. However, there is no evidence of the effects on systemic markers of physiological stress and muscle damage. The purpose of this study is to assess the effects of wearing compression sleeves on the upper limbs while completing a physically demanding activity. In this study, arm ergometry exercises were conducted at 75-watts with and without arm compression sleeves. Saliva samples were collected using passive drooling to assess salivary cortisol and creatine kinase expression, two of the physiological markers of stress and muscle damage. Capillary blood was collected from the earlobe to assess blood lactate levels, a physiological marker of physical exertion. In conclusion, on a high-intense setting, stress markers and muscle damage showed lower expressions when using compression sleeves. This study can be beneficial by helping prevent and detect early signs of muscle trauma.

Keywords: compression sleeves, cortisol, creatine kinase.

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1. Introduction

Professional athletes have been seen wearing compression sleeves during sporting events that require intense muscle power, due to a study that showed increased performance and reduction in recovery time when using compression sleeves (Canavarro, 2019). Ever since, commercialization of compression sleeves has been at its peak for athletes (Gill et al., 2006). The design of the occupational compression arm sleeve creates pressure surrounding the distal area of the extensors and flexors on the arm to support the muscle, connective tissue, and cartilage to help reduce harsh conditions such as deep vein thrombosis and venous insufficiencies (Agu et al., 2004). Additionally, it increases sensory feedback and muscle proprioception, decreasing muscle vibration (Martorelli et al., 2015). However, no studies currently focus on the use of compression sleeves in a controlled condition and working at a lower intensity.

According to the U.S. Department of Labor and Occupational Safety and Health Administration in 2015, the costs associated with repetitive strain injuries such as tightness, soreness, aching, fatigue, and cramping, were more than $20 billion dollars (On Site Therapy, (n.d.b)). Repetitive tasks of high-speed arm and hand movements, long shifts of physical demands, and scheduled short breaks are just a few risk factors that happen in a processing industry (On Site Therapy, (n.d.a)). These work-related musculoskeletal disorders (W.M.S.D.s) are a major public health problem due to the unknown mechanism of identification of early risks (Wilander et al., 2014).

This study aimed to measure the difference in electromyographic activity, along with the expression of the biomarker's cortisol and creatine kinase in saliva, and capillary lactate concentration before and after a series of cycle ergometry exercises with and without using occupational compression arm sleeves.

2. Method

This study begins with recruiting two participants from the college-age student population. The participants were in the age range of 18-25 years and a body mass index (B.M.I.) equal to or less than 25 (kg/m^2) with no history of cardiovascular, musculoskeletal/orthopedic disease or trauma. Participants were advised to abstain from vigorous exercise for 12 hours before volunteering for the clinical testing. Finally, participants began after receiving an approval from the I.R.B. via the consent form.

Three baseline samples of saliva and blood samples from the earlobe were collected in three consecutive days to measure creatine kinase, cortisol expression, and lactate (Lactate Plus, Nova Inc.). The saliva samples were collected in 1.5 mL tubes using passive drool. The concentration of blood lactate concentration (mmol/L) was measured using a blood lactate analyzer (Lactate Plus Lactate Analyzer; Nova Biomedical). Arterial blood pressure was also measured using an automated blood pressure monitor (Omron, Japan). A measurement of the Pressure Pain Threshold (P.P.T.) was conducted during the three consecutive days of baseline followed with before and after each exercise.

Blood flow patterns of the brachial artery were collected before and after each cycle ergometry. Right brachial artery longitudinal imaging was conducted at the end of each session with a high-definition ultrasound machine (MyLab30 Gold Cardiovascular, Easote). The linear array, 12Mhz transducer (LA435, Easote) 5 cm from the antecubital fossa to maintain constant sight of measurement. Subjects were asked to place their right arm on a flat surface using a tripod and foam cut-out to ensure the arm was still as possible since they were upright during the ergometry exercise. Velocities were obtained via Doppler (2-mm window placed in the middle of the artery following the longitudinal axis). Color Doppler was used to determine antegrade (red) and retrograde (blue) flows; then, all positive and negative velocities were established as antegrade and retrograde flow, respectively (Gurovich et. al., 2021)

Each participant completed two sessions of 75-watts with a total completion time of approximately 30 minutes. Sensors were placed to collect electromyographic activity (E.M.G.) on the Extensor Carpi Ulnaris, Flexor Carpi Radialis, and Deltoid. The cardiovascular system was monitored through the participants' heart rate and heart rate variability (H.R.V.). These were recorded continuously using a Polar H10 (Polar Electro, Finland) heart rate sensor connected to the HRV logger recording software (A.S.M.A. B.V., The Netherlands). Participants were asked to wear the heart rate monitor on their chest while performing the exercise session and during breaks.

Each participant has been required to perform each exercise bout with compression sleeves and without compression sleeves. Depending on their measurements, they were provided a recommended fit of the occupational compression sleeves of the forearm or full-arm sleeves (OSTTM Compression Wear, Tallahassee, FL.). In addition, participants completed a warm-up phase performing simple stretching exercises for all large muscle groups and walked on a treadmill for 5 minutes at 3 miles/hour. After the warm-up, each participant completed two sessions of 75-watts resistance with the arm cycle ergometry with the Lode Angio ergometer (Corival, Lode). Each exercise was set to last 10 minutes or

until failure, at a pace of 60 motions/minute. Samples of saliva and capillary blood were collected before and after each exercise bout. Finally, participants were required to rest a minimum of 72 hours between each exercise session.

3. Results

Table 1: Values are shown from a female and male participant doing pre-exercise and post-exercise at 75-watts resistance on the cycle ergometer, followed by the collection of lactates, creatine kinase, and cortisol enzymes.

	Female no Sleeves		*Female with Sleeves*		*Male no Sleeves*		*Male with Sleeves*	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Creatine Kinase (ng/mL)	9.43	9.02	4.63	5.00	8.61	4.59	6.79	6.21
Cortisol (pg/mL)	2807.67	2599.81	3768.47	2968.47	3492.91	3194.54	6951.72	4945.16
Lactate (mmol/L)	1	6.8	1.4	3.8	1.1	5.8	1.1	3.8

Wearing compression sleeves reduced by a factor of two the amount of muscle stress and muscle damage than not wearing compression sleeves. Values shown for the change in the creatine kinase were little to non-existent. However, measurements of lactate levels decreased significantly from pre to post exercise with and without sleeves.

4. Discussion

This study aimed to measure the changes in the electromyographic activity and the expression of biomarkers in the saliva for cortisol, creatine kinase, and lactate before and after a series of arm-cycle exercises. For the female participant presenting exercises at the 75-watts resistance, the creatine kinase dropped by 0.40 with no compression arm sleeves and an increase of 0.40 when wearing compression arm sleeves. In cortisol, there was a drop of approximately 207 when no compression sleeves were worn and a huge decrease of measurement of 800 when wearing compression arm sleeves. With lactate, it dropped double of the amount of measurement when wearing the compression sleeves. For the male participant who was presented with exercises at the 75-watts resistance, the creatine kinase dropped by a factor of two with no compression arm sleeves and a decrease of 0.59 with wearing the arm sleeves. The cortisol dropped approximately by 298 with no arm sleeves worn and a decrease of 2000 when wearing arm sleeves. The lactate measurement dropped by two when the arm sleeves were worn.

By looking at the table above we can see that low expressions on muscle damage and markers of stress were achieved when wearing compression sleeves. It was later found that other factors may have produced an effect on the values shown for muscle damage and muscle stress. A study showed that female participants had a higher value of creatine kinase than male participants. The peak measurement for creatine kinase was 24 hours after the exercise. It was also found that sometimes creatine kinase measurements were usually associated with estrogen changes for females and an adaptation of the exercise for males (Baird et al., 2012).

5. Conclusion

Occupational compression sleeves were used to support trained athletes to improve their performance. By presenting an acute repetitive cycle, this study showed promising results for wearing compression sleeves in an occupational setting lowering the chance of muscle damage and muscle stress. Furthermore, this will help in the long run for any workers that require heavy-intense repetitive labor. Continuation of this study will give a clear understanding on the mechanism behind the design of the compression sleeves and if it will lower the muscle expression. As it is still unclear if these sleeves could help workers based on just two participants. This project can be extended in the future to evaluate different levels of

resistance such as 25 watts and 50 watts, while measuring the creatine kinase levels after 24 and 48 hours for any changes. Comparisons can then be made to see if the occupational compression arm sleeves will work at different intensities.

6. **References**

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