Stable recovery after aerobic exercise with limb blood flow restriction and cooling in individuals with post-concussion syndrome

Yi-Ning Wu, Jessica Gravel, Matthew White, Josh Avery, Terrie Enis, Caroline Stark, Robert C. Cantu

Introduction

Post-Concussion Syndrome (PCS) is a complex disorder in which concussion symptoms last for weeks, months, and rarely years. Recent research has shown that exercise can improve post-concussion symptoms¹. The leading theory supporting this is that human growth hormone is released in response to increased lactate production from exercise, enhancing the brain function and recovery. Blood flow restriction (BFR) and cooling are thought to create an environment favorable for lactate production, in the other words, exercise under BFR and cooling triggers physiological responses at a relatively low intensity. Exercise with BFR and cooling might be beneficial to individuals with PCS and requires further investigation. Therefore, our ongoing study is to examine the outcomes of aerobic exercise with or without BFR and cooling. **Methods**

Individuals who were diagnosed with PCS due to a concussive event within a year, and with modified Somatic Perceptions Questionnaire score less than 10 were recruited and randomly assigned to the aerobic exercise (control) or aerobic exercise with BFR and cooling (experimental) groups. With or without BFR and cooling (Vasper system, Mountain View, CA), both groups rode the recumbent bike (NuStep) for 30 minutes at 60% of the predicted heart rate twice a week for six consecutive weeks followed by six weeks of no intervention. In addition to the aerobic exercise, each participant received the standardized physical therapy as part of the 6-week intervention. A post-concussion Symptoms and Signs checklist was filled daily by the participants to track the symptoms and signs over the period of 12-week study. To examine the lasting effect (any fluctuations of symptoms/signs), the variance of checklist scores for each participant over six weeks after the 6-weeks intervention ended were calculated. Symptoms/Signs checklist scores were analyzed as a whole and as clusters (cognition, mood, somatic, sleep or vestibulo-ocular domains). Data of ten participants with PCS (three in the control group and seven in the experimental group) were analyzed.

Results

Mann-Whitney U test was used to examine the differences between the two groups. The preliminary results showed that variability of the overall symptoms is significantly less in the experimental group (p=0.01). Moreover, the variability of symptoms in sleep domain is significantly less (p=0.01) while the variability of somatic domains shows the trend of being less (p=0.06) in the experimental group.

Discussion

The preliminary results of this study have demonstrated that aerobic exercise with BFR and cooling enhances the recovery of PCS. The effect caused by BFR and cooling maintains and stays more stable after the intervention ends compared to regular aerobic exercise at the same intensity.

Acknowledgements

Oak Foundation Grant OCAY-16-310. **References**

1. Leddy J, John J., John G. Baker, and Barry Willer. "Active Rehabilitation of Concussion and Post-concussion Syndrome." Physical medicine and rehabilitation clinics of North America 27.2 (2016): 437-454



Fig. 1: The variability (variance) of the number of signs and symptoms (A) and the severity of the symptoms/signs (B) in each domain and as a whole. ** p < 0.05, * p < 0.1

Stable recovery after aerobic exercise with limb blood flow restriction and cooling in individuals with post-concussion syndrome

Yi-Ning Wu, PhD¹ Jessica Gravel, DPT² Matthew White, MSc² Josh Avery, DPT² Terrie Enis, MPT^{1,2} **Caroline Stark, BSc¹** Robert C. Cantu, MD²

Introduction

 Post-concussion syndrome (PCS) occurs in ~10% of athletes and ~33% of non-athletes with concussive injuries. • PCS symptoms include headaches, dizziness, sleep, mood and movement disturbances, cognitive dysfunctions, etc. due to potential injuries to the brain and other structures.

- Aerobic exercise may be beneficial for people with PCS by balancing the hemodynamics response and increasing cerebral blood flow.³
- Blood flow restriction (BFR) has shown to result in similar muscular adaptations as higher load exercise during low intensity exercise.⁴
- In theory, human growth hormone is released in response to increased lactate production from exercise, enhancing the brain function and recovery.

To Compare the effects of aerobic exercise with and without body cooling and BFR.

Materials and Methods

Study design

12-week single-blind randomized control study in the hospital setting; designated evaluator for assessing the clinical outcomes of study participants; two concussion specialized physical therapists



Figure 1: Time course of the study: Control group: no body cooling or BFR; Experimental group: with body cooling and BFR



Inclusion criteria

Diagnosed with PCS less than one year; ages 13–55 years old; modified Somatic Perceptions Questionnaire Score <10 (to exclude people with potential problems other than PCS); be able to follow the instructions, and be able to ride a stationary bike for ~30 minutes at a selfselected speed.



Primary outcome measures

- Dr. Cantu Concussion Sign/Symptom Check List (Filled throughout the 12-week study)
- Self-rating scale (26 signs/symptoms, 0–6 scale, total possible score: 156)
- Load: # of symptoms; Severity: scores

Secondary outcome measures

Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT); King-Devick test; Balance Error Scoring System (BESS); SAC (Orientation, Immediate memory and concentration of SCAT3); Quality of life after brain injury (QOLIBRI) or PedsQL™



Figure 2: Characteristics of control and experimental groups

Figures 3A and 3B: Intervention setup and the training protocol. Vasper⁵ machine is used to deliver the body cooling and BFR.

Results

- Mann-Whitney test showed that the recovery rate during the intervention period of both groups did not differ but the experimental group (Vasper) demonstrated more stable recovery (less variance; p=0.01).
- Trends indicate less variabilities of loads in emotional and sleep domains. (p<0.1; Rosner BA, 2011)



Figure 4A: Exemplar data of 12-week severity changes of individuals from Control and Experimental groups. *Figure 4B: Comparisons between two groups*

• Mann-Whitney Test showed the improvement of QoL observed in the experimental group was significantly larger than that in the control group (p=0.01). The same finding was found at the Follow-up (p=0.008).

Figure 4B: Comparisons

Load Fluctuations







Control Group Experimental Group

• ImPACT, BESS, King-Devick Test, SAC improved after the intervention in both groups but there was no significant difference between two groups.



Figure 5: Changes of QoL scores at two time points: right after 6-week intervention and at the follow-up. Significant continuous improvement is observed in the experimental group.

Discussion and Conclusions

• Aerobic exercise alleviates the post-concussive symptoms of individuals who have been diagnosed with PCS for less than one year.

• Aerobic exercise with body cooling and Blood Flow Restriction (BFR) did not exacerbate the postconcussive symptoms.

• More stable recovery was found in the individuals who exercised at 60% predicted maximum heart rate under BFR and body cooling as compared to the individuals without body cooling and BFR.

• Grouped data showed that people who underwent the aerobic exercise with cooling and BFR had relatively larger improvement in quality of life compared to the group without.

1. Dept. of Physical Therapy, University of Massachusetts Lowell, Lowell MA, USA; 2. Dr. Robert C. Cantu Concussion Center, Emerson Hospital, Concord MA, USA 3. Kurowski et al, 2017; Leddy et al, 2010 & 2013 4. Loenneke and Pujol, 2009; Loenneke et al, 2010 5. Vasper, Mountain View, CA, USA

Acknowledgement This study is supported by the Oak Foundation (OCAY-16-310). The authors acknowledge and thank all of the participants and families who took part in the study.





emersonhospital.org