Muscular responses to acute and chronic finger flexors blood-flow restriction training in experienced sport climbers.

Titouan Perrin*[1], Hugo Randy[1], Pyrène Santal[1], Nicolas Tourette[1], Stephane Doutreleau[1], Marie Coudurier[1], Michel Guinot[1], Xavier Hugues[2], Franck Quaine[2], Violaine Cahouet[2], Hugo Kerhervé[3], Mathieu Marillier[1], and Julien Brugniaux[1]

[1]Laboratoire HP2 – Institut National de la Santé et de la Recherche Médicale - INSERM, Université Grenoble Alpes – France

[2]Grenoble Images Parole Signal Automatique – Centre National de la Recherche Scientifique, Université Grenoble Alpes, Institut polytechnique de Grenoble - Grenoble Institute of Technology, Institut Polytechnique de Grenoble - Grenoble Institute of Technology – France

[3]Laboratoire Mouvement Sport Santé – Université de Rennes 2, Université de Rennes 2 : EA7470, Université de Rennes 2 – France

Résumé

INTRODUCTION:
In sport climbing, high-load resistance training (HLRT) is traditionally used for performance enhancement, focusing especially on improving finger specific isometric flexor digitorum (FD) muscle strength and endurance (Devise et al., 2022). However, specific FD training at high intensity can be traumatic, often leading to injuries. Low-load blood-flow resistance training (LLBFRT) has been shown to be a promising substitute to HLRT to promote strength and endurance while reducing tissue mechanical strain (e.g. lower training loads) (Patterson et al., 2019). However, the physiological responses associated with LLBFR to climbing-specific exercises until exhaustion are poorly understood (Andersen et al., 2023; Javorský et al., 2023). Therefore, the aims of the study were to i) examine acute and chronic muscular responses to LLBFRT during climbing specific FD training, and ii) compare these responses to HLRT.

METHODS:

An acute and a chronic phase were completed. The acute phase involved 15 advanced to elite climbers who conducted two bouts of three sets of FD isometric intermittent exercise on a hangboard under two experimental conditions in a randomized order: 1) HLRT (3 sets of 10-12 repetitions, ~70% maximal voluntary contraction, MVC); 2) LLBFRT (3 sets of 14-20 repetitions, ~40% MVC with cuff pressure set at 60% of the individual limb occlusion pressure). Exercise intensity was individualized in order to reach exhaustion at the end of each session. Finger flexors muscle oxygenation was continuously monitored using near-infrared spectroscopy (NIRS); muscle fatigue was quantified as MVC decrement 1, 5 and 15 min post exercise. Perceived discomfort, effort, and finger pain were assessed at the

*Intervenant

end of each set. The chronic study phase involved 36 advanced to elite climbers randomized into 3 groups: LLBFRT, HLRT and a control group (CON). Participants of the LLBFRT and HLRT groups performed the training session presented in the acute study phase twice a week for 5 consecutive weeks, while the CON group maintained their usual climbing routine. Before and after the training protocol, participants attended the laboratory twice: i) to assess FD MVC, endurance and oxygenation (NIRS); ii) to quantify brachial artery blood-flow by Doppler ultrasound during FD specific isometric contractions between 0 to 60%MVC.

RESULTS:

In the acute phase, higher muscle fatigue was observed in LLBFRT compared to HLRT only 1 min post exercise (25 ± 8% vs 19 ± 7% of MVC loss, p=0.016), with no differences 5 and 15 min post exercise. LLBFRT led to greater muscle deoxyhemoglobin values (+20 ± 25%, d=0.9), greater upper-limb discomfort during inter-sets recoveries, and less finger pain during exercise. In the chronic phase, LLBFRT and HLRT induced similar improvements in FD MVC (+9 ± 8%, d=1.0 and + 13 ± 11%, d=1.2, respectively), and endurance (+22 ± 15%, d=1.7 and +24 ± 21%, d=1.2, respectively). Brachial blood-flow during specific contractions increased following LLBFRT (+19 ± 31%, p=0.008) but not after HLRT (+12 ± 37%, p=0.516).

DISCUSSION

The increased acute muscle fatigue induced by LLBFRT may be due to the exacerbated metabolic stress emanating from reduced oxygen supply and limited metabolite clearance, which may have contributed to increase upper-limb discomfort compared to HLRT. Comparable chronic adaptations on FD MVC and endurance were induced by LLBFRT and HLRT despite different training stimuli, that is, higher metabolic stress and lower mechanical strain in LLBFRT.

CONCLUSION

LLBFRT may therefore be used as an efficient substitute to HLRT to enhance specific FD muscular capacities and promote vascular adaptations, while reducing exercise intensity and finger pain.

REFERENCES :

Andersen, V., Hermans, E., Vereide, (...) & Saeterbakken, A. (2023). Comparison of finger flexor resistance training, with and without blood flow restriction, on perceptional and physiological responses in advanced climbers. *Scientific Reports*, 13(1).

Devise, M., Lechaptois, C., Berton, E., & Vigouroux, L. (2022). Effects of Different Hangboard Training Intensities on Finger Grip Strength, Stamina, and Endurance. *Frontiers in Sports and Active Living*, *4*, 862782.

Javorský, T., Saeterbakken, A., Andersen, V., & Baláš, J. (2023). Comparing low volume of blood flow restricted to high-intensity resistance training of the finger flexors to maintain climbing-specific strength and endurance: A crossover study. *Frontiers in Sports and Active Living*, 5, 1256136.

Patterson, S., Hughes, L., Warmington, (...) & Loenneke, J. (2019). Blood Flow Restriction Exercise: Considerations of Methodology, Application, and Safety. *Frontiers in Physiology*, *10*, 533.