Two-Weeks of Remote Ischemic Preconditioning Alters Sympathovagal Balance

Richard N. Gardner1, Jeann L. Sabino-Carvalho2, Lauro C. Vianna2, James A. Lang1

1Department of Kinesiology, Iowa State University, Ames, IA
2Faculty of Physical Education, University of Brasilia, Distrito Federal, Brazil

Abstract

Introduction: Remote ischemic preconditioning (RIPC), elicited by brief, intermittent periods of ischemia followed by reperfusion, has cardioprotective effects. Our lab recently found that repeated bouts of RIPC improves microvascular function; however, it is unclear whether autonomic function would also be affected. We hypothesize that heart rate variability (HRV) will be altered following two weeks of repeated RIPC.

Methods: Eleven healthy adults (age = 22 ± 2 years, 6 males, 5 females, BMI = 23.1 ± 3.4) performed two weeks of RIPC over three 4-day periods, each separated by one day break. Each RIPC session consisted of 4 repetitions of 5 minutes of upper arm flow occlusion interspersed by 5 minutes of reperfusion. Both the pre- and post- RIPC resting heart rate was collected with lead II electrocardiogram (ECG) while the participants were comfortably lying in a semi-recumbent position in a quiet, dimly lit thermoneutral environment. Power spectral density and symbolic dynamics were used to assess HRV from ≈590 beat ECG segments.

Results: Two weeks of repeated RIPC decreased the percentage of V0 fragments (pre RIPC = 17.1 ± 6.9, post-RIPC = 6.9 ± 4.9%, P < 0.05) and increased the percentage of V2 fragments (pre-RIPC = 42.9 ± 12.1%, post-RIPC = 55.2 ± 10.9%, P < 0.05), while decreasing the LF/HF ratio (pre-RIPC = 1.1 ± 0.6, post-RIPC = 0.7 ± 0.5, P < 0.05). Conclusion: Both the spectral and fractal analyses indicate that repeated RIPC shifts sympathovagal balance by increasing parasympathetic and decreasing sympathetic activity (Iowa State University, IRB#17-606).

Introduction

Remote ischemic preconditioning (RIPC), elicited by brief periods of ischemia followed by reperfusion, is a method of inducing protection against ischemic-reperfusion injury in the cardiovascular system.

Cardioprotection following RIPC is abolished after blockage (Matsitokaya et al., 2012) and denervation (Basaly et al., 2012) of vagal ganglionic neurons in rats.

In humans with stable heart failure, cardiac function and heart rate variability (HRV) are increased following RIPC (Chen et al., 2017).

Both power spectral density and symbolic dynamic analyses have been performed in healthy controls and persons with Parkinson’s disease to assess sympathovagal balance (Vianna et al., 2016).

Hypothesis: Heart rate variability (HRV) will be altered after following two weeks of repeated RIPC training.

Methods

Study Population

Healthy young adults (n = 11, age = 22 ± 2 years, BMI = 23.1 ± 3.4)

Non-hypertensive (resting mean arterial pressure = 87 ± 2 mm Hg)

Not diagnosed with cardiovascular or metabolic diseases

Not taking prescription medications or using tobacco products

RIPC Training

Daily RIPC sessions were administered to subjects. Each session consisted of 4 repetitions of upper arm blood flow occlusion with a blood pressure cuff inflated to 200-220 mm Hg on the dominant arm for 5 minutes followed by deflation for 5 minutes (Figure 1).

Results

Sympathetic Activity: Greater reliance on LF spectral density and no variation in pattern variation (2 V).

Parasympathetic Activity: Greater reliance on HF and increased pattern variation (0 V).

Conclusion

Both power spectral density and symbolic dynamic analyses indicate a shift toward greater parasympathetic and less sympathetic activity following two weeks of RIPC.

Thus, altered sympathovagal balance following repeated RIPC may be beneficial in improving autonomic function in humans.

References


Acknowledgments: We would like to thank the funding agency, NASA - Iowa Space Consortium Grant, that supported the project. We also thank the research participants and the student investigators for their time.