

Monitoring muscle oxygenation and myoelectric activity after damage- inducing exercise

by

Sirous Ahmadi

BS (Nursing), MA (Exercise Physiology)

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Supervisors Statement

As supervisors of Sirous Ahmadi doctoral work, we certify his thesis 'Monitoring muscle oxygenation and myoelectric activity after damage-inducing exercise' to be suitable for examination.

Signed _____

Date _____

Associate Professor Glen M Davis

Signed _____

Date _____

Dr Peter J Sinclair

Discipline of Exercise and Sport Science,
Faculty of Health Sciences,
The University of Sydney

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Abstract

In this thesis, three experiments were conducted to monitor: (i) muscle oxygenation and electromyographic activity of the biceps brachii after exercise-induced muscle damage (ii) muscle oxygenation after downhill walking-induced muscle damage, and, (iii) muscle oxygenation following a bout of vigorous concentric exercise.

Maximal eccentric exercise (EE) of biceps brachii resulted in significantly increased mean resting oxygen saturation and decreased deoxyhaemoglobin. During isometric contractions at 50% and 80% of subjects' maximum voluntary torque (MVT), oxygen desaturation and resaturation kinetics and volume were significantly decreased after EE, and these declines were significantly prevalent over the following 6 days. Additionally, a significant shift in median frequency intercept (measured by electromyography; EMG) towards lower frequencies was observed during isometric contractions at both 50% and 80% MVT after EE in the exercised arm.

After an exhaustive session of downhill walking, another form of EE, resting total haemoglobin and oxyhaemoglobin decreased. Furthermore, during isometric contractions at 30%, 50% and 80% of MVT, prolonged and significant increases were observed in oxygen desaturation and resaturation kinetics and volumes after ambulatory EE. In contrast to the two EE experiments, concentric contractions did not evoke any prolonged changes in muscle oxygenation.

Collectively, the findings of this thesis revealed significant and prolonged changes in muscle oxygenation at rest and during exercise, following sessions of strenuous eccentric exercise. Although not clear, the possible mechanism responsible for the changes in muscle oxygenation after EE could be increased resting muscle oxygen utilization due to probable muscle damage and a subsequent requirement of energy demanding repair processes. Concentric exercise resulted in fatigue, but it did not affect muscle oxygenation. Although a prolonged reduction in EMG median frequency intercept was observed after EE, this was not closely time-associated with the biochemical, anthropometric or functional markers of muscle damage.

Candidate Statement

I, Sirous Ahmadi, hereby declare that this submission is my own work and that it contains no material previously published or written by another person except where acknowledged in the text. Nor does it contain material, which has been accepted for the award of another degree.

In addition, ethical approval from the Human Research Ethics Committee of the University of Sydney was granted for the studies presented in this thesis. Participants were required to read a participant information document and informed consent was gained prior to data collection.

Name: Sirous Ahmadi

Signed _____

Date _____

Presentation of Work

Parts of the work presented in this thesis have been published and/or presented in the following forums:

Refereed articles

- Ahmadi S, Sinclair PJ, Davis GM (2007). Muscle Oxygenation Following Concentric Exercise. *Isokinetics and Exercise Science* 15 (4), 309-319.
- Ahmadi S, Sinclair PJ, Foroughi N, Davis GM (2007). Electromyographic activity of the biceps brachii after exercise-induced muscle damage. *Journal of Sport Science & Medicine* 6(4), 461 - 470.
- Ahmadi S, Sinclair PJ, Foroughi N, Davis GM (2006) Muscle Oxygenation after Exercise-Induced Muscle Damage, *Applied Physiology, Nutrition & Metabolism* (submitted for publication November 2007).
- Ahmadi S, Sinclair PJ, Davis GM (2008). Muscle oxygenation after downhill walking-induced muscle damage. *Clinical Physiology and Functional Imaging*, 28 (1), 55-63.

Proceedings

- Ahmadi S, Sinclair PJ, Davis GM (2007). Muscle oxygenation after downhill walking-induced muscle soreness. Presented at the 54th annual meeting of ACSM, New Orleans, Louisiana (USA). *Med Sci Sport Exer* 39 (5), S39.
- Ahmadi S, Sinclair PJ, Foroughi N, Davis GM (2006). Monitoring muscle oxygenation kinetics after exercise-induced muscle soreness. Presented at the 11th

annual Congress of ECSS, Lausanne (Switzerland). The 11th annual Congress of European College of Sport Science 2006 (ISBN: 3-939390-35-6), 568.

- Ahmadi S, Sinclair PJ, Foroughi N, Davis GM (2006). Electromyographic activity in biceps brachii after eccentric exercise-induced muscle soreness. Presented at the 11th annual Congress of ECSS, Lausanne (Switzerland). The 11th annual Congress of European College of Sport Science 2006 (ISBN: 3-939390-35-6), 569.

- Ahmadi S, Sinclair PJ, Foroughi N, Davis GM (2006). Monitoring muscle oxygenation kinetics after exercise-induced muscle soreness. Presented at the 2nd AAESS conference. Sydney (Australia). Proceedings of the 2nd Australian Association for Exercise and Sport Science conference 2006 (ISBN: -0646-46536-8), 65.

- Ahmadi S, Sinclair PJ, Davis GM (2006). Monitoring oxygenation kinetics after downhill walking-induced muscle soreness. Presented at the 5th Health Research Conference 2006 “From Cell to Society 5”. Peppers Fairmont Resort, Leura (Australia). Proceedings of the 5th Health Research Conference 2006 “From Cell to Society 5”. (ISBN: 1-86487-853-3), 8-7.

Prizes and awards

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Dedication

I would like to dedicate this work to my daughter, Atria and my wife, Nasim. Since Atria's birth during 2006, my spiritual life has changed and her smiles have made my life happier than ever.

Preface

This thesis is comprised of seven chapters. Chapter 1 provides an introduction and rationale for the studies presented in this thesis. Chapter 2 presents a review of literature on muscle oxygenation, muscle damage and the popular techniques for the assessment of muscle damage and oxygenation. Chapters 3, 4, 5 and 6 report on effects of eccentric and concentric exercise on some parameters of muscle oxygenation and myoelectric activity. Chapter 7 presents a general discussion and conclusion on the studies presented in this dissertation. Chapters 3, 4, 5 and 6 have the references provided at the end of each chapter. These chapters are presented according to the format required by the journals to which they were submitted, that is *Applied Physiology Nutrition and Metabolism* (Chapter 3; in review), *Journal of Sport Science and Medicine* (Chapter 4; published), *Clinical Physiology and Functional Imaging* (Chapter 5; published) and *Isokinetics and Exercise Science* (Chapter 6; published). Ethics approval was gained from the Human Research Ethics Committee of the University of Sydney for all studies prior to data collection.