Muscle synergies during bench press

By
Mathias Vedsø Kristiansen

Strength training, in various forms, is a widely practiced form of physical training. It is generally thought that both morphological mechanisms and neurological mechanisms play a role in the increase in strength following training. As the human body represents a linked mechanical system, postural activity specific to the task, bracing, and proper setup of a base of support, is critical for the expression of maximal strength. Thus, the precise activation and timing of agonists, synergists, antagonists and stabilizer muscles is of paramount importance to forceful execution of the task at hand. This can be referred to as inter-muscular coordination. The general aim of this thesis was to provide further insight into inter-muscular coordination during bench press. This aim was pursued by investigating the reliability of inter-muscular coordination, differences in inter-muscular coordination between groups of different training status and the effects of strength training on inter-muscular coordination. For that purpose, muscle synergies were extracted from EMG data recorded during submaximal bench press by means of nonnegative matrix factorization. Currently, there is a lack of knowledge regarding the reliability of muscle synergy extraction, and the effects of various training modalities on muscle synergies.

In Study (I), the between-day reliability of extracting muscle synergies during bench press was assessed and found to be strong to very strong. In Study (II), a cross sectional study design was used to assess if differences in muscle synergies reside in subject groups of very different training status. Expert powerlifters were found to exhibit larger inter-subject variability in the synergy activation coefficient and less inter-subject variability in the muscle synergy vectors responsible for the concentric phase of the bench press, compared to untrained subjects. In Study (III), a randomized controlled trial was carried out in an attempt to establish a causal relationship between training and alterations in muscle synergies. Performing a cross validation test of the extracted muscle synergies, revealed that changes had occurred in the muscle synergies of the group that performed strength training for five weeks, while no changes had occurred in the control group.

The present thesis provided novel data on the between-day reliability of muscle synergies. Further, it was documented that distinct differences in muscle synergies was present between expert powerlifters and untrained subjects, and that five weeks of strength training induced changes in muscle synergies during bench press.
To fulfill the requirements for the Ph.D. degree, Mathias Vedsø Kristiansen has submitted the thesis: Muscle synergies during bench press, to the Faculty Council of Medicine at Aalborg University.

The Faculty Council has appointed the following adjudication committee to evaluate the thesis and the associated lecture:

Reader Jonathan Folland  
Loughborough University  
United Kingdom

Professor François Hug  
University of Nantes  
France

Chairman:  
Associate Professor Jesper Franch  
SMI, Aalborg University  
Denmark

Moderator:  
Associate Professor Mark de Zee  
SMI, Aalborg University  
Denmark

The Ph.D. lecture is public and will take place on:

**Program for Ph.D. lecture on**

**Tuesday 8 December 2015**

by

**Mathias Vedsø Kristiansen**

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Chairman:  
Associate Professor Jesper Franch

Moderator:  
Associate Professor Mark de Zee

13.00 Opening by the Moderator

13.05 Ph.D. lecture by Mathias Vedsø Kristiansen

13.50 Break

14.00 Questions and comments from the Committee

Questions and comments from the audience at the Moderator’s discretion

16.00 (No later than)  
Conclusion of the session by the Moderator

After the session a reception will be arranged