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Published in:
Proceedings, 4th Annual Meeting of the Danish Society of Biomechanics, 26 October 2012, Aarhus, Denmark

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

Functional implications of stretch reflex up-conditioning: Preliminary results

Priscila de Brito Silva[1], Yukiko Makihara[1], Natalie Marachacz–Kersting[1], Aiko K. Thompson[2], Anderson S. C. Oliveira[1], Uwe G. Kersting[1]

[1]Dept. of Health Science and Technology, Aalborg University; [2]Helen Hayes Hospital, New York State Dept. of Health, USA

Introduction: Stretch reflexes are involuntary automatic responses from the muscles to its own fibers stretch; it works as a protective mechanism for the muscle tissue and enhance its function. It has been demonstrated that reflex size can be operantly conditioned; however there is a lack of information regarding functional relevance of such training in terms of how much of the conditioning can be transferred to more dynamic tasks. Thus, biomechanical measurements may add functional relevance to changes in stretch reflex size. The present study aimed to verify the effects of operant upconditioning of the soleus muscle stretch reflex of healthy subjects on afferent contributions to ankle stiffness and control of tibial angle during perturbations to balance while standing on one leg. Soleus excitability, tibial displacement during single-leg perturbed task and afferent contribution to stiffness were verified pre and post up-conditioning.

Methods: Soleus muscle excitability (H-reflex in relation to M_{max} peak to peak raw EMG size – H:M ratio) and tibial displacement (TD – inclination of tibia in relation to the ground) were assessed during unperturbed and perturbed single-leg standing (backwards perturbations (BPTB - 66 cm.s-1), delivered randomly throughout 30 trials. Afferent contribution to stiffness of the ankle joint was defined as the difference between total stiffness obtained during voluntary and intrinsic stiffness obtained during electrically stimulated contractions. Stiffness was measured during soleus muscle stretch while subjects performed either voluntary or electrically stimulated plantar flexion in different intensities (12.5, 25, 37.5, 50, 62.5, 75, 87.5 and 100% of maximal voluntary plantar flexor torque). Subjects then took part of 30 sessions of soleus stretch reflex up-conditioning (UPCON) where, based on the feedback provided, subjects were asked to increase the size of reflex response.

Results and Discussion: Here we present results of two subjects – one successfully up-conditioned and one unsuccessfully conditioned. SC showed substantial increase in afferent contribution to ankle stiffness after UPCON, while UC presented similar values pre and post UPCON. Only slightly increases in TD peak during BPTB for both SC (~4%; 0.28°) and UC (~2%; 0.15°) were found after UPCON (Figure 1 A). Furthermore, time to TD peak increased 24 ms (17%) for SC after UPCON, while UC did not alter time to TD peak (2.5 ms, ~1.8%) (Figure 1 B). The increased soleus excitability found for SC may suggest altered strategies to reach stabilization while attempting to stand still during BPTB, by reduced coactivation of ankle muscles and increased contribution from soleus muscle to decelerate tibial translation. On the other hand, UC may have used higher co-activation as a strategy to reach stability on BPTB. Increased time to reach the peak of movement is related to higher muscular eccentric control and may protect passive structures from overloading in specific tasks, moving the centre of mass forward. These initial results indicate that neuroplasticity is induced by up-conditioning and can be transferred to functional tasks. The resulting increase of excitability could be verified in balance tasks and led to enhancement of stiffness at the ankle. These findings have yet to be verified on a wider sample in order to understand its implications on performance for healthy and dysfunctional subjects.

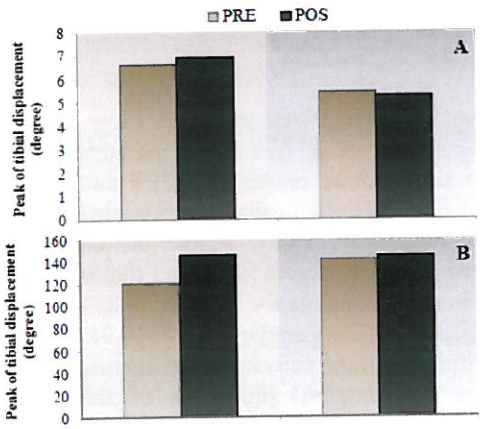

Figure 1: A- Mean time to TD peak pre (brown bar) and post (black bar) UPCON for Successful and Unsuccessful subjects. B – Mean TD peak pre (brown bar) and post (black bar) UPCON for Successful (SC) and Unsuccessful (UC) subjects.