24th Annual ECSS Congress Prague/Czech Republic, July 3-6 2019

The anticipation of varying gravity levels in human ballistic movement

Waldvogel, J.1, Freyler, K.1, Monti, E.4, Albracht, K.2,3, Stäudle, B.3, Gollhofer, A.1, Narici, M.4, Ritzmann, R.1,5

1: University of Freiburg, 2: German Sport University Cologne, 3: University of Applied Sciences Aachen, Germany, 4: University of Padua, Italy, 5: Praxisklinik Rennbahn, Basel, Swiss

INTRODUCTION:
The stretch-shortening-cycle (SSC) describes the neuromechanical pattern underlying locomotor movements. The SSC is defined by a stretching of a pre-activated muscle-tendon complex immediately followed by a muscle shortening in the concentric (CON) push-off phase (3). Regarding the efficiency of the SSC, both the muscle's pre-activation (PRE) and the reflex activity after touchdown are important to regulate the muscle's stiffness which is crucial for the energy management (1). These factors are supposed to be modulated in response to load variation (2). This study aimed to identify load-dependent changes in biomechanical and neuromuscular characteristics of the SSC in drop jumps (DJs) under conditions of varying gravity (g) levels during a parabolic flight.
METHODS:
DJs were executed in under (0.1-1g, UG), normal (1g, NG) and overload (1-1.9g, OG) gravitation. In 11 subjects peak force (Fmax), rate of force development (RFD) and 2D kinematics (sagittal plane) were recorded, and leg stiffness, ankle joint power and maximal ankle joint moment were calculated. Electromyographic activities (EMG) in M. soleus (SOL) and gastrocnemius medialis (GM) were assessed before (PRE) and during ground contact (eccentric phase (ECC), CON). Changes in GM fascicle length (FASC) were determined through ultrasound. Friedman test was used for statistical analysis.
RESULTS:
Jumping under gradually increasing gravitation increased Fmax, RFD, ankle joint flexion, leg stiffness and ankle joint power ($p<0.05$). Ankle joint moment was highest in NG and reduced in UG and OG ($p<0.05$). EMG for SOL and GM progressively increased in PRE and partially in CON with increasing g load. In contrast to this EMG in ECC was highest in NG and diminished below and above NG ($p<0.05$). Accordingly, GM FASC lengthened in OG compared to the UG conditions ($p<0.05$).
CONCLUSION:
These findings emphasize that biomechanically relevant kinematic adaptations in response to varying gravity levels are accompanied by phase-specific modulations in neural control (3). Gravitational variation is anticipated and compensated by a load-adjusted muscle activity to execute the SSC (2). Importantly, PRE, CON and ECC were differently affected: While PRE and CON demonstrate a load-dependent increase in EMG, ECC shows a downregulated neuronal activity associated with FASC lengthening. This reduction may help to protect the musculoskeletal system from exceeding muscle and tendon safety factors (4) possibly caused by central inhibition (2).

References
1) Ritzmann R. et al. J Appl Physiol 121:1187-1195,2016.
2) Taube W. et al. Exerc Sport Sci Rev 40: 106–115, 2012.
3) Komi P. Exerc Sport Sci Rev 12: 81–121, 1984.
4) Biewener A.A. J Exp Biol 208:1665-1676, 2005.

Contact
janice.waldvogel@sport.uni-freiburg.de

Topic: Neuromuscular Physiology

Presentation form: Oral