TRAINING AND REHABILITATION WITH CONTROLLED ECCENTRIC OVERLOADING - EVALUATION AND APPLICATION OF A NEW DEVICE

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Eccentric muscle actions constitute an integral part of normal human movements. Skeletal muscle can produce higher force in eccentric than in concentric and isometric muscle actions. Chronic adaptations of muscle performance tend to be muscle action type specific. Therefore, eccentric overloading has become an essential component of training and rehabilitation. To be able to quantify and characterise the training stimulus there is a need for standardized equipment.

The aim of this work was to construct an apparatus that would allow for eccentric overload to be applied under controlled conditions. Furthermore, it should be applicable in exercises commonly used in training and rehabilitation. In this presentation, the machine and its specifications will be described as well some of its applications.

The apparatus, called Bromsman , consists of a barbell suspended with wires connected to a hydraulic pump that raises and lowers the barbell at an adjustable speed set by a hydraulic valve. The upper limits of loading, range of motion and speed are 500 kg, 1 m and 0.6 m.s-1, respectively. There are two industrial scales that measure the vertical component of the ground reaction force, e.g. under each foot in standing.

First, the validity of the machine itself was evaluated. The speed recordings of the built-in displacement sensor were found to correspond well with those obtained using a motion capture system (ProReflex) at 120 Hz ($r = 0.99$). A phase of constant velocity could be identified at each set speed. Relationships between barbell loads, speed settings and actual movement speeds were established over the range of normal usage. Applying known weights onto each scale demonstrated linearity with respect to magnitude and independence regarding location of application.

Then the combined man-machine reliability was tested using a group of habitually active males ($n = 13$, 28 - 55 yrs) performing squats (220 kg, 0.11 m.s-1), where maximal voluntary resistance was to be applied during the lowering phase, on two occasions separated by two weeks. The results showed that the variation between the two occasions was of a similar order of magnitude as earlier reported for reproducibility of strength performance (CV = 18%).

Preliminary observations and subjective experiences from training in Bromsman have been positive both for increasing performance in top athletes and causing pain relief in patients with diffuse knee problems. A prospective randomised study is now on its way on patients with patellar tendinopathy.

Bromsman has proven to be a device capable of producing eccentric overload under standardized and reproducible conditions. Extreme loads can be handled at varying speeds with minimum risks for the trainee. In standing exercises the balance component is maintained, which appears to be of significance for the training result. The possibility of feedback to the experimenter and the trainee of the force under each foot makes individual dosage of training load possible, which is valuable e.g. in rehabilitation of a unilateral injury. Also, the exerted resistive force can be varied voluntarily, upon instruction, in different phases of the ongoing exercise to train specific deficiencies or avoid position specific pain.