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ABSTRACT

Weight training typically offers constant external load during coupled shortening (concentric) and lengthening (eccentric) muscle actions in sets of consecutive repetitions until failure. However, skeletal muscle inherently has the capability to produce greater force in the eccentric compared with the concentric action, which allows for greater loading during the eccentric action, i.e. “eccentric overload”. Thus, traditional weight training uses a loading strategy, which appears to result in incomplete motor unit recruitment and muscle use during most concentric actions and all eccentric actions of a set. In contrast, the flywheel device, using the inertia of flywheel(s) to generate resistance, allows for maximal voluntary force to be produced throughout each concentric action with brief episodes of eccentric overload. This type of loading may potentially increase motor unit recruitment and muscle use during acute resistance exercise, and as a result may induce greater training adaptations when bouts are repeated.

The aim of the present thesis was to explore the fatigue response of the quadriceps muscle during flywheel exercise, and to compare quadriceps muscle use and adaptations to training in response to acute or chronic resistance exercise using traditional free weights/weight stack machine or a flywheel apparatus.

Multichannel surface electromyographic (EMG) signals were recorded from the quadriceps muscle of nine men, to assess fatigue during consecutive concentric-eccentric actions performed using the flywheel device. There was marked fatigue during both the concentric and eccentric actions. Results further showed a discrepancy between normalized rate of decrease of instantaneous mean power spectral frequency (iMNF) and conduction velocity (CV), which may imply that iMNF will not accurately reflect changes in CV during dynamic actions. Furthermore, to assess and compare quadriceps muscle use in the two loading features, five resistance trained men performed free weight and flywheel resistance exercise on separate days. Flywheel exercise induced greater over all muscle use, showing greater over all EMG activity and increase in transverse relaxation time (T2) of magnetic resonance images, compared with free weight exercise. The greater muscle use shown with flywheel exercise appeared to result from the greater forces produced during the flywheel compared with free weight exercise. Furthermore, when fifteen healthy men were assigned to five weeks of unilateral knee extension training using either a flywheel device or a weight stack machine, flywheel training induced more robust muscular adaptations, i.e. increased volume of all four individual quadriceps muscles and increased maximal isometric strength, compared with weight stack training.

In summary, flywheel resistance exercise resulted in more robust muscular adaptations compared with traditional resistance exercise using weights. Furthermore, the flywheel device induced greater forces and muscle use during acute exercise. The marked fatigue response during the coupled concentric-eccentric flywheel exercise is supported of near maximal effort and hence muscle use, which is further suggested to, at least in part, explain the more robust muscular adaptations following chronic flywheel resistance exercise compared with traditional weight training.