Electromyographic activity and muscle power during and after a muscular hypertrophy resistance exercise protocol

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Introduction

The execution of multiple sets with submaximal loads (such as 65-85% of 1RM) and short to moderate rest intervals between sets (1-2 min) is considered as the “optimal” stimulus for training-induced muscle hypertrophy with resistance exercise. The application of a “hypertrophy” type protocol leads to acute decreases in isometric force production and voluntary neural activation of the muscles (Linnamo et al. 1998). However, no data exist about the changes in muscle electrical activity and power output during the execution of a hypertrophy protocol. Furthermore, it is unknown how dynamic performance and muscle activation are altered by a hypertrophy protocol. The purpose of the present study is to examine i) electromyographic (EMG) activity during the execution of a muscular hypertrophy protocol in relation to power output and ii) EMG activity and mechanical power with the use of a light (40% of 1RM) and a heavy load (80% of 1RM) following a typical heavy resistance hypertrophic protocol.

Methods

Sixteen males (age: 20.7±1.1 yrs., height: 174.4±4.6 cm, and body mass: 71.7±8.1 kg) performed 6 sets of 10 repetitions with 2 min of rest in the squat exercise (bending down to 65±6.3° knee angle). The initial load was 74.9±0.8% of the 1RM and decreased throughout the exercise bout when the subjects were assisted to perform the required number of repetitions (63.3±10.2% at the 6th set). Before the execution of the protocol, immediately after and 30 minutes after the end of the protocol, the subjects performed 4 repetitions (as fast as possible) with the loads of 40% and 80% of 1RM, and a maximum isometric knee extension. The EMG activity of vastus medialis (VM), vastus lateralis (VL), and rectus femoris (RF) was recorded during the concentric phase of the lift and the isometric knee extension. Vertical displacement of the loads as a function of time was monitored with a linear encoder attached on the barbell and interfaced to an electronic microprocessor (MuscleLab, Model PFMA 3010e, Ergotest A.S, Langensund, Norway). This allowed the calculation of average power for each repetition and for each set.

Results

Average power decreased (p<0.05) progressively until the 7th repetition in all sets. Average quadriceps (AQ), VM, VL, and RF electrical activity increased (p<0.05) progressively until the 6th repetition within each set. Average power was lower (p<0.05) during the 3rd and the 4th set compared to the 1st set and during the 5th and the 6th set compared to the 1st and the 2nd set. Muscle electrical activity did not change systematically from set to set. AQEMG/Power, VMEMG/Power and VLEMG/Power ratios increased (p<0.05) from set to set. Post-exercise power output decreased (p<0.05) both with the 40% and the 80% of 1RM loads. The decrease in power output with the 80% load was higher (p<0.05) than that of the 40% load (13% vs 22%). Post-exercise muscle electrical activity decreased (p<0.05) measured both with the 40% and the 80% loads. EMG/Power ratio did not change with the 40% load while it increased (p<0.05) with the 80% load for all muscles (Fig 1). Maximum isometric force during the knee extension decreased (18.6%; p<0.05) after the protocol with no changes in the EMG activity of the muscles.

Discussion/Conclusion

Peripheral factors appear to be responsible for the decline of muscle performance during the execution of a hypertrophy protocol since power output decreases during the execution of a set or from set to set due to the decrease in the load used, while at the same time muscle activity increases within the set and remains unchanged from set to set, respectively. However, neural fatigue may also occur following a hypertrophy protocol since muscle electrical activity decreases during an explosive action performed both with a light (40% of 1RM) and heavier load (80% of 1RM). Nevertheless, power output measured with a heavy load decrease more following a hypertrophy protocol due both to central and peripheral factors while the minor decrease in power output with a light load may be associated primarily with neural fatigue.

References


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