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Analysis of the frequency bands of the electromyographic signal during resistance training of the biceps brachii muscle with low versus high loads

Abstract:

Objective: This study analyzed the behavior of electromyographic (EMG) signal frequency bands during resistance training using low versus high loads.

Methods: A randomized, blinded, prospective study was conducted with 16 healthy, sedentary participants aged 20–40 years. Each participant completed a unique training protocol for each biceps brachii (BB) muscle, randomly assigned: Training A utilized 40% of the maximal load, while Training B employed 70%. The primary outcome was the post-training behavior of EMG signal frequency bands, with secondary outcomes evaluating muscle strength and hypertrophy. EMG data were recorded from the biceps brachii at four levels of force output (20%, 40%, 60%, and 80% of maximal voluntary contraction [MVC]) before and after a hypertrophy-oriented training program. Signal analysis employed the Fast Fourier Transform (FFT) with a Hamming window, 50% overlap, and 1024 points. The resulting power spectrum was categorized into six frequency bands: 5–13 Hz, 13–30 Hz, 30–60 Hz, 60–100 Hz, 100–200 Hz, and 200–300 Hz.

Results: Multivariate analysis revealed significant interactions for Training versus Frequency Band ($F = 104.63$, $P < 0.0001$, Eta = 0.41) and for Training versus Groups versus Frequency Band ($F = 3.34$, $P = 0.005$, Eta = 0.02). Both low-load (40% 1RM) and high-load (70% 1RM) resistance training increased power in the 13–30 Hz frequency band while reducing power in the 60–100 Hz and 100–200 Hz ranges.

Conclusions: Resistance training with 40% and 70% of 1RM alters EMG signal frequency characteristics in the biceps brachii, increasing power in the 13–30 Hz band and decreasing power in the 60–100 Hz and 100–200 Hz bands. These findings contribute to understanding neuromuscular adaptations during resistance training.

Biography

Luis Eduardo, is a PhD student and holds a Master's degree in Rehabilitation Sciences from UNINOVE. He spe- cializes in spinal physiotherapy (Santa Casa de São Paulo) and has degrees in Physiotherapy (UNINOVE) and Physical Education (PUCRS). His research focuses on biomechanics, signal analysis, hospital-based physical education, gerontology, and aging, with publications on muscle architecture, exercise, biofeedback, and biome- chanics. Additionally, he is a high-performance trainer in combat sports and rugby. Luis is an active member of the Brazilian Society of Biomechanics and the Brazilian Society for Pain Studies, combining academic expertise with practical experience in sports and rehabilitation.