THE EFFECT OF A SEVEN WEEK LIFTING PROGRAM ON ELECTROMECHANICAL DELAY IN FEMALE TRACK ATHLETES.

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INTRODUCTION

In most all athletic endeavor, there exists a window in time in which an applied force will favorably affect performance. In most cases these windows of opportunity grow shorter as the level of performance increases. In the case of most athletic pursuits, the more elite participants not only create greater forces, they create them faster. A major factor in the rate of creation of functional force and power, output of a muscle is inherently linked to the elastic characteristics of the musculo-tendonus structures.

Numerous researchers have demonstrated that the skeletal musculo-tendonus unit has the capacity to store elastic strain energy (Alexander and Bennet-Clarke, 1977; Bell and Jacobs, 1986; Burke and Edgerton, 1975; Winter and Brooks, 1991; Vitasalo and Komi, 1981). This suggests quantifiable elastic properties. Force output of any elastic system is directly related to the relative distention of the system. The greater the distention the greater the force. Conversely, to achieve any force output, an elastic system must be stretched a discrete distance. The greater the force, the greater the required distance. A stiffening of these elastic characteristics would result in a smaller discrete distance of stretch to reach a given force and would therefore result in a faster rise in force in a musculo-tendonus unit. This mechanism has been suggested to account for the time delay between onset of EMG activity and the initiation of movement known as electromechanical delay (Winter and Brookes, 1991; Vitasalo and Komi, 1981).

Plyometric training has grown in popularity since its introduction to the U.S. in the 1970s. Today it seems to be the technique of choice for training power in most ballistic and explosive sports. Coaches and athletes alike associate improvements in bounciness and rebound quickness to plyometric training programs. This study was undertaken as the first in a series of studies to investigate the effect of training methods on muscle elastic characteristics. Its intent was to investigate the change in elastic characteristic of the triceps muscle, as measured by electromechanical delay, following a seven week plyometric program.

METHODOLOGY

Ten collegiate female Track and Field athletes, age 19.4 (± 1.2), who competed in the sprinting and jumping events, volunteered for the study, signed informed consent and were randomly assigned to one of three test groups. For each test group one additional triceps exercise was added to their seven week 3x per week conditioning weight cycle. Group 1 (n=3) performed a standard triceps extension exercise, three sets of 12 reps, from a supine position at a weight appropriate to their conditioning level. Group 2 (n=4) performed an explosive triceps extension, three sets of 12 reps, by throwing a 2 kg medicine ball upwards from the supine position with no counter movement. Group 3 (n=3) performed a plyometric triceps extension, three sets of 12 reps, from the supine position, using a 2 kg medicine ball dropped from a 24 inch height.

Electromechanical Delay (EMD) was tested one week prior to and one week following the weight training cycle. At each test session subjects performed 20 maximum velocity elbow extension from a relaxed state on verbal command. Movement was resisted by a threshold force device, instant field reversing electromagnet, designed to release at preset force of 8, 22, 27, or 36 pounds. Simultaneous wrist acceleration and triceps EMG were collected on five trials at each release force. EMD was defined as the time between onset of wrist acceleration and onset of EMG activity.

Mean EMD times were calculated by averaging the five trials for each release force in each testing session. Data were analyzed using a MANOVA Repeated Measures design.

RESULTS

The result of the mean electromechanical delay times calculated from averaging the five trials for each condition at each test session are shown in Table 1. MANOVA repeated measures analysis done on the SPSS Statistical Data Analysis software package revealed statistical differences between test conditions both pre and post at the $p=0.01$ level, but showed no main effect differences for lift technique and no interaction between lift technique and threshold force.

RECOMMENDATIONS

The EMD times calculated from this study ranged between 98 ms and 205 ms. These are, not surprisingly, two to four times longer than EMD times reported in other studies that used no threshold resistance to the movement (5). The data can be considered consistent with the idea that loading of series elastic elements accounts for electromechanical delay, however the study does not address other factors of muscle activation which may have contributed. Based on this study we cannot support the conjecture that plyometric exercise stiffens the elastic characteristics of skeletal muscle. However the number of subjects we were able to recruit was small and resulted in a very low statistical power.

Table 1. Mean Electromechanical Delay times in seconds.

	Pre				Post			
	Threshold Force (lbs.)				Threshold Force (lbs.)			
Lift Technique	8	22	27	33	8	22	27	33
Triceps Extension	0.193	0.183	0.177	0.228	0.097	0.029	0.173	0.191
	(0.18)	(0.11)	(0.10)	(0.15)	(0.04)	(0.05)	(0.12)	(0.09)
Medicine Ball Throw	0.115	0.138	0.160	0.167	0.083	0.136	0.157	0.241
	(0.05)	(0.03)	(0.04)	(0.03)	(0.01)	(0.03)	(0.04)	(0.11)
Plyometric Exercise	0.145	0.196	0.182	0.208	0.114	0.151	0.148	0.184
	(0.06)	(0.10)	(0.07)	(0.07)	(0.04)	(0.05)	(0.04)	(0.05)
	0.151	0.172	0.173	0.201	0.098	0.139	0.159	0.205
	(0.10)	(0.08)	(0.06)	(0.09)	(0.03)	(0.04)	(0.07)	(0.08)

The following recommendations for future studies can be made:

1. Use of indwelling rather than surface electrodes may serve to improve the EMG signal and result in a more exact identification of EMG onset.
2. Use a micro switch to record moment of release of threshold release device. This will increase the accuracy of the EMD calculation.
3. Use a force recording system to monitor rise in force prior to threshold release.
4. Use a mechanical pivot that allows only elbow extension to control shoulder internal rotation in the testing session.
5. Increase the population for the study.

REFERENCES

Alexander, R. McN. and Bennet-Clark, H. C. (1977). Storage of elastic strain energy in muscle and other tissues. Nature 265:114-117.

Bell, D. G. and Jacobs, I. (1986). Electromechanical response times and rate of force development in males and females. Med Sci Sports Exer 18:31-36.

Burke, R. E. and Edgerton, V. R. (1975). Motor unit properties and selective involvement in movement. Exercise and Sport Sciences Review 3:31-81.

Winter, E. M. and Brookes, F. B. C. (1991). Electromechanical response times and muscle elasticity in men and women. Eur J Appl Physiol 63:124-128.

Vitasalo, J. T. and Komi, P. V. (1981). Interrelationships between electromyographic, mechanical, muscle structure and reflex time measurements in man. Acta Physiol Scand 111:97-103.