Physiological Aspects of Physique Building Part 2 – Compartmentalization

Researched and Composed by Jacob Wilson, BSc. (Hons), MSc. CSCS

Introduction

The anaerobic energy pathways govern in large part the capacity for peak performance during supramaximal exercise. Within this framework, capacity, power, and the time continuum will be discussed. Further, each step in the glycolytic pathway will be carefully analyzed, from reactants, to products. Additional attention will be partitioned to eleven specific enzymes responsible for the direction, and speed of glycolysis. Finally, techniques used to measure anaerobic energy systems will be reviewed.

Bodybuilding is a sport of body intramuscular and intermuscular symetry. Intermuscular symmetry consists of a balance between aspects such as the long and short heads of the biceps, as well as the sternal and clavicular heads of the pectoralis. Intermuscular was discussed by Arnold Squartzenegger when he stated that ' in order to increase a muscle one inch, the whole body would have to increase.

Antonio (1999) the worlds leading authority on Non-Uniform Hypertrophy provided numerous lines of evidence for non uniform hypertrophy and has summed what these evidences suggest as follows:

Skeletal muscle is a complex tissue that shows a prodigious capacity for growth. The notion that an individual muscle is just a compilation of muscle fibers that traverse from origin to insertion is simplistic and egregiously flawed. There are obvious differences between muscles with regard to size, architecture, and fiber composition. Moreover, within the same muscle, one can find regional differences in fiber size and fiber composition. Within a single fiber, one can find differences in MHC isoform expression and diameter.

Thus, it would make sense that the response of skeletal muscle to resistance training would be a nonuniform hypertrophy. In fact, the idea that a muscle would respond in a uniform fashion would seem implausible in light of the fact that there are distinct physiological/anatomical differences within a single muscle.

The existing studies (both acute and chronic training) show that within a given muscle, there is not a homogeneous response with regard to electrical activity (as measured by EMG), changes in muscle area, muscle fiber area, or even fiber number.

The purpose of this paper is to examine the concept of compartmentalization as it relates to intermuscular symetry.

Compartmentalization

Studies have confirmed the existence of neuromuscular compartments (Wilson, 2003, An Unmatched Analysis of the Elbow Joint). One compartment is a "portion" of a muscle which is supplied by a particular nerve branch. This compartment contains, in many cases, motor units with distinct functions. Further, the number of muscle fibers in a neuromuscular compartment varies. Van Zuylen et al.(1988) explains by stating that, "Most muscles are not activated homogeneously; instead the population of motor units of muscles can be subdivided into several subpopulations (79)." These scientists further state that:

"Inhomogeneous activation of the population of motor units in a muscle is **a general finding** and is not restricted to some multifunctional muscles (79)." The term inhomogeneous refers to differing activation. That is, all muscle fibers are not recruited for one task in a single muscle; rather, differing tasks can call a specific portion of a muscle into play. Van Zuylen et al.(1988) confirms the complexity of the issue by stating: "On the other hand, motor units in muscles are not necessarily activated if their mechanical action contributes to a prescribed torque. For example, there are motor units in the medlial biceps that are activated during flexion torques, but not during supination torques." What was explained is extremely vital to this article and your training. It was noted that certain parts of the muscle were activated during flexion, but not during supination. This is the concept of compartmentalization and there is much experimental evidence for it.

Chaunad, Pratt and Loeb (1989) investigated a cat's biceps femoris musculature and found that, "The BF muscle consists of three neuromuscular compartments: anterior (BFa), middle (BFm) and posterior (BFp). Each compartment is innervated by a separate nerve branch." It was found that each compartment had distinct neuromuscular functions. English and Letbetter(1982) studied the gastrocnemius (the large posterior calf muscle) and found that, "The lateral gastrocnemius is more complex and contains three distinctly identifiable heads, each of which is a unipennate band of fibers coursing between a proximally attached aponeurosis of origin and a distal aponeurosis of insertion"

In the Journal of Physical Therapy, English et al. summarizes the "partitioning hypothesis" as follows:

1. " The partitioning hypothesis is based on the fact that an individual muscle is arranged in a more complex array than simply fibers attaching at aponeuroses, tendons, or bones with a single muscle nerve innervation."

2. They state that neuromuscular compartments "are distinct subvolumes of a muscle, each innervated by an individual muscle nerve branch and each containing motor unit territories with a unique array of physiological attributes."

3. Finally, they assert what many other Scientists have confirmed: "These data are complemented by physiological studies, the results from which suggest that partitions may have functional or task-oriented roles; that is, ***different portions of one muscle may be called into play depending on the task demands of the situation."***

A great deal of evidence supports the above discussion. As one example, one of the most manipulated muscles in the body is the biceps brachii. Bodybuilders utilize numerous angles while training it. In support of such protocols Segal (1992) wanted

to see if the clear Electrophysiological evidence that the human biceps brachii muscle is organized into functional neuromuscular compartments had an anatomical basis(electrophysiological in that, clear electrical studies have supported that the biceps do not act in a homogenious manner, but rather task specific). Here is a summary of their findings:

"The purpose of this study was to determine whether there was an anatomical basis for these compartments. Dissection of the biceps revealed both architectural and nerve branching pattern compartmentalization within the muscle. Although the biceps brachii is grossly subdivided into long and short heads, these heads are further subdivided into roughly parallel architectural compartments. Moreover, these architectural compartments usually receive a private nerve branch, thus supporting the notion that the human biceps brachii has neuromuscular compartments."

Thus, there is not only functional evidence, but now anatomical evidence for neuromuscular compartmentalization in the biceps. However, there is much more supporting evidence for the above. Brown (1993) conducted a study which was rightfully named, "Further evidence of functional differentiation within biceps brachii" They studied whether supination during various phases of flexion could activate different portions of the muscle. It was found that when the elbow joint was fully extended (or actually when extended below 90 degrees), that the long head of the biceps was more activated than the short head during supination movements, and the short head was more activated when the elbow was flexed past 120 degrees of flexion than the long head.

Romeny, van der Gon, and Gielen (1988) discovered something truly astonishing. These scientists studied the long head of the biceps. In doing so, it was revealed that motor units in the lateral aspect of the muscle were specialized for flexion of the elbow joint, motor units located medially were activated for supination of the forearm, and motor units located in the center of the head were specialized for both movements superimposed on one another.

Conclusion

Presented was an introduction into one of a number of mechanisms responsible for differential effects of various angles and exercises used for the effect of sculpting. Further aspects of this subject will be addressed as this series progresses. For additional insight however, the following articles will be of use:

Monumental Masterpiece - Creating A Cerebral Portrait

Is The All Or None Applicable To An Entire Muscle

An Unmatched Analysis of The Elbow Joint & Its Surrounding Musculature Part II

Jacob Wilson

President Abcbodybuilding / Co-Editor Journal of HYPERplasia Research

References

1. Antonio, Jose (2000). Nonuniform Response of Skeletal Muscle to Heavy Resistance Training: Can Bodybuilders Induce Regional Muscle Hypertrophy? The Journal of Strength and Conditioning Research: Vol. 14, No. 1, pp. 102–113.

2. Windhorst, U., Hamm, T.M., & Stuart, D.G. Behavioral and Brain Sciences, 12, 629-682

3. van Zuylen EJ, Gielen CC, Denier van der Gon JJ Coordination and inhomogeneous activation of human arm muscles during isometric torques. J Neurophysiol. 1988 Nov;60(5):1523-48

4. Segal RL Neuromuscular compartments in the human biceps brachii muscle. Neurosci Lett. 1992 Jun 8;140(1):98-102.

5. English AW, Letbetter WD Anatomy and innervation patterns of cat lateral gastrocnemius and plantaris muscles Am J Anat. 1982 May;164(1):67-77.

6. Brown JM, Solomon C, Paton M Further evidence of functional differentiation within biceps brachii Electromyogr Clin Neurophysiol. 1993 Jul-Aug;33(5):301-9

7. Herrmann U, Flanders M. Directional tuning of single motor units J Neurosci. 1998 Oct 15;18(20):8402-16.

8. Weeks OI, English AW. Compartmentalization of the cat lateral gastrocnemius motor nucleus. J Comp Neurol. 1985 May 8;235(2):255-67.

9. Willett GM, Hyde JE, Uhrlaub MB, Wendel CL, Karst GM. 2001. Relative activity of abdominal muscles during commonly prescribed strengthening exercises. J Strength Cond Res. 2001 Nov;15(4):480-5.