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No atrophy let's hypertrophy for better sporting events

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Abstract

Strength is the basic form of endurance. Without strength, one cannot exert force for any activity. Strength is again dependent upon the quality and quantity of muscle mass and it is a highly trainable aspect, on the other hand, one of the important aspects of muscle atrophy is inactivity for a relatively long period of time. In the sporting arena, every athlete tries to maximize strength along with other components of fitness for obtaining the best result. Hypertrophy is dependent upon several factors such as resistance training, proper nutrition, tempo of the exercise, load and recovery, and so on. Cluster training plays a vital role to aggravate muscular hypertrophy. Modern systematic resistance training methodology is helpful for muscle strength and minimizes the scope of atrophy. The present research article scientifically discussed the various aspects of muscle hypertrophy and the procedure to implement it for better performance in sports.

Keywords. Atrophy, hypertrophy, sports.

Introduction

Strength can be one of the biggest advantages athletes have over their competitors. Also, if you want to stay on top of the strengths of today's sportswear, you need to maintain a certain level of strength. Muscle hypertrophy is one of the two main factors of strength and is also the best option if you are looking to increase strength as well as contractibility of muscle mass. This also makes training for muscle hypertrophy for contractual muscle mass for bodybuilders (Viru & Viru, 1993; Atha, 1981; McArdle et al., 1996).

The terms "muscle mass" and "muscle strength" are often used simultaneously, but each has a different meaning for sports science. Muscle weight is body size; muscles tend to be larger because of strenuous physical activity and exercise, but not all. Muscle strength is one of the legitimate strengths, including endurance, flexibility, strength, and speed. For almost all sports purposes, muscle strength is a more important asset than weight. However, in most contact sports, especially those with specific role players, muscle size is important for an athlete's ability to locate and position an opponent; athletic strengths and strategies employed by an athlete once the establishment is established will be the most important qualities (Guyton & Hall, 2000; Häkkinen, 2003).

Building muscle mass is a reason for lifting external weights. When exercising, we are more concerned with building bigger muscles because of their appearance. Most athletes lift weights to improve their athletic performance, increasing their muscle mass is more important for their performance. Hypertrophy training of one kind or another is fundamental to almost every sports training program conducted through scientific periodization.

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There are several reasons for this. First of all, the size of the muscle should be very strong. If the muscles are strong, they should be strong enough to explode. Therefore, hypertrophy training, if done properly, can make a runner stronger and more explosive. Second, hypertrophy training has a very positive effect on the ligaments and bones, which are often our weakest links during athletic performance. The high dose and moderate rest associated with hypertrophy training stimulate the muscles and tendons to adapt to the training. Third, body weight means larger size and weight. This is important for any game that may affect communication (Cissik, 2016).

On the other hand, there is muscle atrophy, is the decrease in muscle strength due to a decrease in muscle mass, muscle diameter, or the number of muscle fibers. Depending upon the muscle weakness atrophy can be partial or complete. Muscle atrophy is often a result of disease such as cancer, AIDS, chronic obstructive pulmonary disease, renal failure, congestive heart failure, and burns. Starvation for long period can also result in muscle atrophy. Simple disuse of muscle, either due to a sedentary lifestyle or because of bed rest, can also cause muscle atrophy (Boonyarom & Inui, 2006).

Muscle atrophy is typical to some extent during aging. Atrophy over time due to aging is known as sarcopenia. Though not completely clear, it is suspected that the cause of sarcopenia is a combination of the decline of satellite cells to regenerate cells of skeletal muscle fibers, as well as a decreased sensitivity or availability of hormone cues, including growth factors that stimulate maintenance muscles through regeneration of muscle fiber cells from satellite cells.

Loss of muscle not due to atrophy or sarcopenia is indicative of diseases that result in structural defects of muscles (muscular dystrophy) or autoimmune responses that degrade muscle structure (myopathies) Boonyarom & Inui, 2006).

So there are three different concepts of decrease of muscle mass i.e.

Atrophy: To wither or waste away.

Dystrophy: A wasting of body tissues, of genetic origin, or due to inadequate or defective nutrition.

Sarcopenia: Age-related loss of skeletal muscle, resulting in frailty. Often found together with osteoporosis, a loss of bone that is similarly associated with the aging process.

Current research findings on structural and functional changes that occur during muscle atrophy and hypertrophy reveal an increase in total mass of a muscle as hypertrophy, whereas a decrease in total mass of a muscle is referred to as atrophy. In hypertrophy, the rate of synthesis is much higher than the rate of degradation of muscle contractile proteins, leading to an increase in the size or volume of an organ due to the enlargement of existing cells (Bruusgaard et al., 2010; Keller et al., 2014).

Background

Before considering conditions of muscle growth and muscle atrophy, it is useful to highlight some points.

- Skeletal muscles are heterogeneous with respect to fiber type and metabolic properties and therefore they respond drastically, with respect to same stimulus. For instance, slow muscles, such as the soleus, are less sensitive to starvation compared to fast muscles (Baskin et al., 2015; Sandri et al., 2006), while during disuse such as that induced by hind limb suspension, the soleus atrophies faster than glycolytic (fast) muscles (Brocca et al., 2017). Importantly, the atrophy program diverges within the fast muscles during the same catabolic condition (Brocca et al., 2017). Therefore, each catabolic condition differs from the others in terms of muscle susceptibility to atrophy as well as induction of an atrophy program and within the same catabolic situation, different muscles activate peculiar atrophy-related programs (Brocca et al., 2017).
- Despite the fact that most of the pathways regulating muscle mass, such as Insulin/IGF1 or TGFβ/Activin/BMP, impinge both on protein synthesis and degradation, changes in protein turnover leading to muscle hypertrophy or atrophy do not always proceed according to the simplistic view that muscle growth is consequent to increased protein synthesis and decreased protein degradation, while muscle atrophy results from decreased protein synthesis and increased protein degradation. In fact, exercise does promote the synthesis of new proteins but simultaneously activates autophagy–lysosome and ubiquitin–proteasome-degradative systems (Grumati et al., 2011). Conversely, during protein breakdown, the amino acids released by lysosome and proteasome directly stimulate mTOR (Liu & Sabatini, 2020) and

therefore, protein synthesis might increase during muscle atrophy (Roberta et al., 2021).

Types of Muscle Hypertrophy

Muscle hypertrophy and muscle hyperplasia is an entirely different thing.

During hypertrophy, contractile elements enlarge and the extracellular matrix expands to support growth (Vierck et al., 2000). This is in contrast to hyperplasia, which results in an increase in the number of fibers within a muscle. Contractile hypertrophy can occur by adding sarcomeres in series or in parallel. The majority of exercise-induced hypertrophy subsequent to traditional resistance training programs results from an increase of sarcomeres and myofibrils added in parallel (Paul & Rosenthal, 2002; Tesch & Larsson, 1982). When skeletal muscle is subjected to an overload stimulus, it causes perturbations in myofibers and the related extracellular matrix. This sets off a chain of myogenic events that ultimately leads to an increase in the size and amounts of the myofibrillar contractile proteins actin and myosin and the total number of sarcomeres in parallel. This, in turn, ugments the diameter of individual fibers and thereby results in an increase in muscle cross-sectional area (Toigo & Boutellier, 2006). This has been termed ‘‘sarcoplasmic hypertrophy,’’ and may result in greater muscle bulk without concomitant increases in strength (Siff & Verkhoshansky, 1999). Hypertrophy is the increase in size and volume due to the enlargement of contractile protein and extracellular matrix.

In case of hyperplasia, the diameter of muscle fibers are same but the number of muscle fibers increased due to pathological conditions. Muscle cells remain the same size but increase in number.

There are three types of hypertrophy viz. i) Transient, ii) Sarcoplasmic and iii) Myofibrillar.

i) Transient: Increase in the muscle size immediately following exercise due to fluid accumulation (from blood plasma) in intercellular and interstitial spaces of the muscle.

ii) Sarcoplasmic: Increase the volume of the sarcoplasmic fluid within the muscle cell with no accompanying increase in muscle strength.

iii) Myofibrillar: Increase in the size of the contractile proteins (actin and myosin) contributing to force producing capabilities of the muscle (functional hypertrophy).

Mechanism of Hypertrophy

Two important principles acts as the foundation of muscle growth (Brown, 2017):

- First, the muscle must be stimulated to increase in size. However, that stimulus must be anabolic in nature. The anabolic stimulus appears to be related to the amount of resistance used in a lift and the associated neural activation in both men and women (Campos et al., 2002; Schuenke et al., 2012). Heavier resistance produces higher neural activation voltages in the recruitment of motor units. High voltage is needed for neural stimuli to activate high-threshold motor units; this high voltage also exposes lower-threshold motor units to the neural stimuli because recruitment always progresses from low- to high-threshold motor units. This was evidenced by biopsy training studies on the thigh muscle from Dr. Robert Staron’s research groups.
- Second, increasing muscle size requires energy and the building blocks for new protein growth, both of which come from a properly designed and well-balanced diet that incorporates adequate calories and needed nutrients. As discussed in greater detail in chapter 4, nutrient intake is vital for optimal muscle development. The body needs carbohydrate, protein, and fat to repair and remodel muscle. Thus, everyday dietary patterns (including the timing of nutrient intake around the workout), appropriate sleep, and a healthy lifestyle all contribute to the effectiveness of muscle repair and, therefore, muscle growth.

Factors of Skeletal Muscle Atrophy & Hypertrophy

Muscle wasting (Size) & weakness (Strength) are characterized by a decrease in muscle fiber cross-section areas, myonuclear number, protein content, and strength.

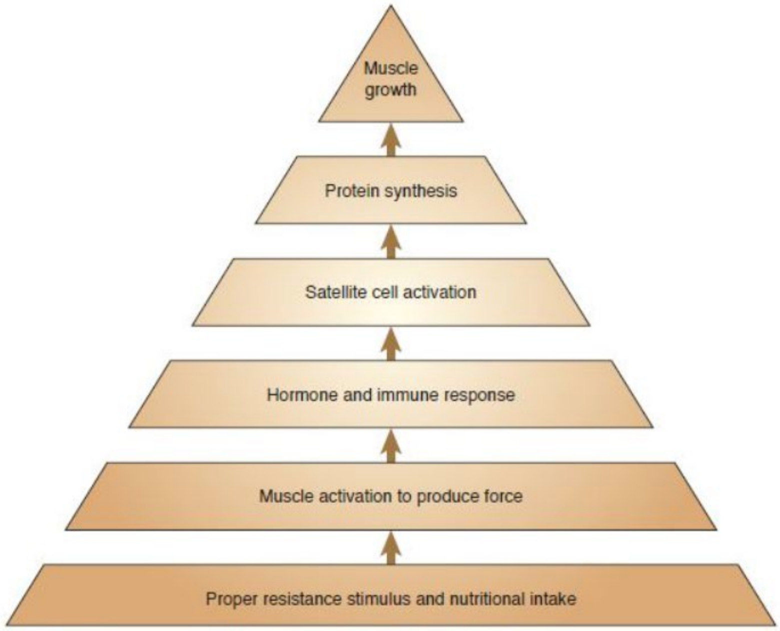

Figure 1. Muscular Growth (Brown, 2017).

Factors for Atrophy:

- Immobilization and inactivity
- Disease related
- Drug related (Glucocorticoid)
- Inadequate nutritional intake
- Sarcopenia (due to ageing)

Factors for Hypertrophy:

i) **Nutrition (amino Acid):** In general, protein supplementation pre- and post-workout increases physical performance, training session recovery, lean body mass, muscle hypertrophy, and strength. Specific gains, differ however based on protein type and amounts. The leucine content of a protein source has an impact on protein synthesis, and affects muscle hypertrophy. Consumption of 3–4 g of leucine is needed to promote maximum protein synthesis. For maximal muscle hypertrophy to occur, weightlifters need to consume 1.2-2.0 grams (g). Protein kilogram. (kg)$^{-1}$ and > 44–50 kilocalories (kcal)·kg^{-1} body weight daily (Lemon P. 1998, Lemon PW, 1991; Kreider R. 1999). Protein supplementation pre-and/or post-workout increases physical performance (Hoffman et al., 2009), training session recovery (Hoffman et al;2010) lean body mass (Cribb & Hayes 2006) muscle hypertrophy (Hulmi, 2009) and strength (Hartman, 2007). Branched-chain amino acids (Lusin, Isolusin and valine) acts as Subtracting protein synthesis and signal to adaptation, BCCAs can directly stimulate the mTOR pathway.

ii) **Metabolic Stress:** The energy production during strength training takes place mainly through the anaerobic energy metabolism. When all energy reserves are exhausted and/or the supply of new energy is too slow, metabolic stress occurs. The body reacts to this stress with adaptation processes that trigger an increased hypertrophy reaction (Goto, 2005).

iii) **Anabolic Hormones & Cytokines:** Hormones and cytokines play an integral role in the hypertrophic response, serving as upstream regulators of anabolic processes. Elevated anabolic hormone concentrations increase the likelihood of receptor interactions, facilitating protein metabolism and subsequent muscle growth (Crewther, 2006). Many are also involved in satellite cell proliferation and differentiation and perhaps facilitate the binding of satellite cells to damaged fibers to aid in muscular repair (Toigo & Boutellier, 2006; Vierck, 2000). Insulin and IGF1 are released from hypertrophic response to resistance training. Mechano-Growth factor, Testosterone, and growth play vital role in muscle hypertrophy (Schoenfeld, 2010),

iv) **Mechanical Tension:** Mechanically induced tension in the muscle, generated by the use of force is an essential stimulus for muscle growth. More precisely, the muscle has to be overloaded so that the growth stimulus aims at the increased performance (Goldberg, 1975). The tension in the muscle during strength training "disturbs" the integrity of the muscle and consequently adjustment mechanisms are initiated (Toigo & Boutellier, 2006). Whether an induced tension alone is sufficient to induce hypertrophy is unlikely, but neuronal adaptation symptoms can be observed.

v) **Muscle Damage:** Strength training can lead to local damage to the muscles. The damage can occur on the smallest level (molecular level), up to large damages (tears in the musculature), which become noticeable through sore muscles (Vierck, 1975). The reaction to these micro-traumas can be compared to an inflammatory reaction. As soon as the damage is noticed by the body, cells necessary for the repair move to the site of the event and ensure the healing process (Weir & Brown, 2012).

Training Variables Manipulation for Hypertrophy

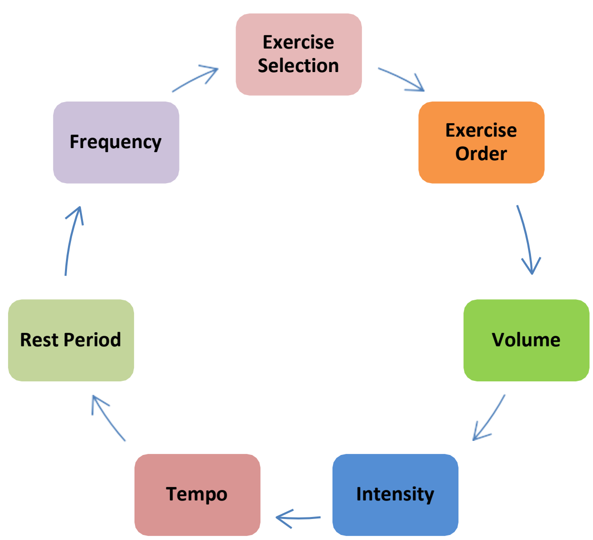

Figure 2. Variables for muscular hypertrophy (Bruusgaard et al., 2010).

The scientific term for building muscle is *hypertrophy* — an increase in the size of the muscle cells (fibers). It's what many of the athletes are chasing, but building muscle is much harder if not training correctly to maximize muscle growth. The training components of muscle hypertrophy is discussed as follows.

Selection of Exercise

Include multi-joint and single-joint exercises as they are useful for building muscle, but multi-joint movements are superior in this regard. Multi-joint exercises are the ones in which more than a single pair of joints are working during a given exercise. Including both types of concentric and eccentric movements is important to maximally develop the target muscle. Varying exercises allow an athlete to stimulate more muscle fiber recruitment, essentially working the muscle from different positions, planes, and angles (Henneman, E. 1957).

Henneman's size principle describes relationships between properties of motor neurons and the muscle fibers they innervate and thus control, which together is called motor units. Motor neurons with large cell bodies tend to innervate fast-twitch, high-force, less fatigue-resistant muscle fibers, whereas motor neurons with small cell bodies tend to innervate slow-twitch, low-force, fatigue-resistant muscle fibers. In order to contract a particular muscle, motor neurons with small cell bodies are recruited (i.e. begin to fire action potentials) before motor neurons with large cell bodies. It was proposed by Henneman (Henneman, 1957; Willardson, 2007).

Exercise Order

a) Explosive Power: Movement with maximal intent first when fresh Type II recruitment.
b) Bilateral multi-joints(compound) exercise second prior to single joint movements.
c) Allow the greater levels of volume-load in multi-joints movement and enhance mechanical tension.
d) Also enables smaller muscular involved in a single joint exercise to be exposed to higher anabolic
(T) hormone levels earlier in a workout.

Volume

a) Low Reps (1-5 RM) enhance neuromuscular adaptations necessary for development of maximal strength.
b) These adaptations allow for use of heavier loads.
c) These generate greater Mechanical Tension (at a given intensity)
d) Conversely higher Rep training (12+ RM) can help attenuate exercise – induce rise in lactate & H+ (Metabolic stress)

e) It delay onset of Fatigue
f) Thus, enabling greater training volume (Schoenfeld, 2013; Weir & Brown, 2012).

Intensity

- 1RM= Maximum weight that can be lifted with single repetition with maintaining correct biomechanics.
- Inverse Relationship = Inverse relationship between load (weight) and volume (Reps) performed.
- Hypertrophy Stimuli = High repetition training causes greater metabolic stress moderate load enable relatively training volumes
- Heavy load = Greater mechanical tension
- Hypertrophy Range= Costing the continuum, Mix of heavy enough to recruit Type II fibers
- Research tells us that loads less than 65 percent of your 1RM are not considered significant enough to promote hypertrophy. Low rep ranges (1-5) are proven to be most optimal if your goal is strength development. The number of Set may be increase up to 10. For hypertrophy, mechanical tension is the most important stimuli Total weekly training volume is more important than training frequency (Schoenfeld, 2013).

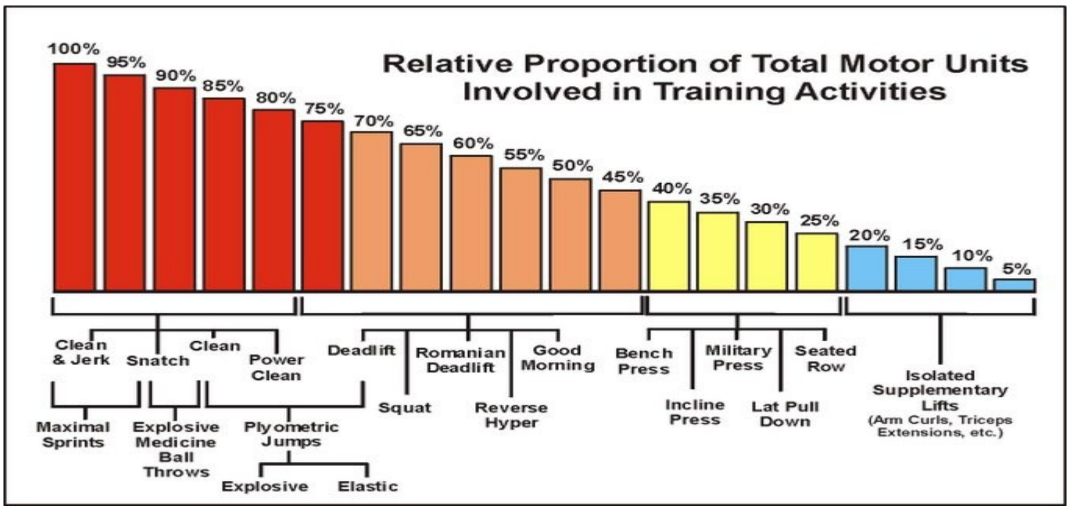

Figure 3. Relative Proportion of total Motor Units involved in Training (Hansen & Francise, 2002).

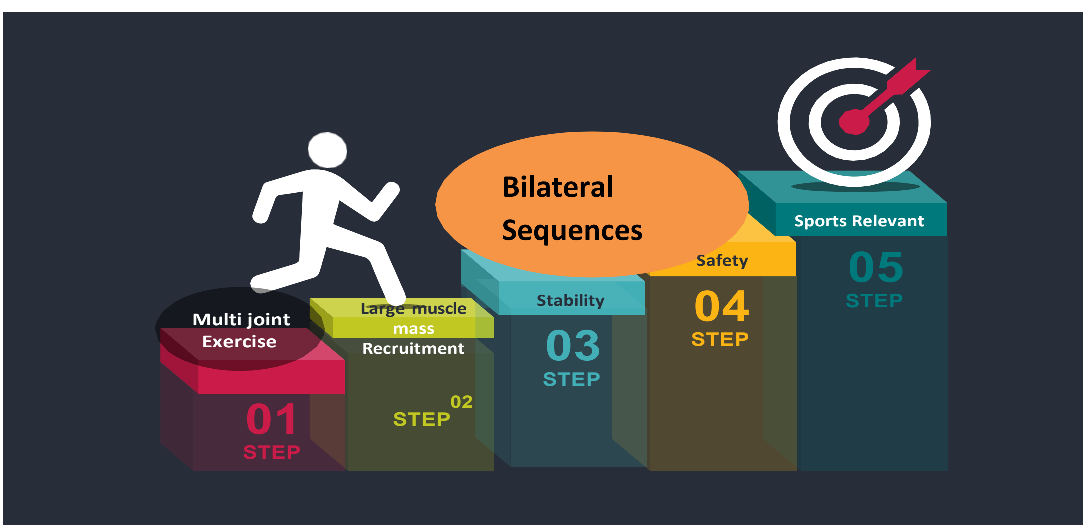

Figure 4. Exercise selection General principles (Weir & Brown, 2012).

Tempo (Contracting Velocity)

Concentric contraction is explosive to promote type II fibre recruitment and eccentric contraction is to be fast but controlled to promote stretch reflex and increase total work and mechanical tension. Tempo is the speed of the repetition. Before we talk about that, there are a few terms to understand. Research suggests you should lift faster and more explosively on the concentric phase and use a slower controlled speed on the eccentric (Fry, 2004, Krieger James; 2010, Willardson, 2007).

Rest Period

Rest duration may be one of the most overlooked training variables for hypertrophy. For maximum strength development, rest time should be 3-5 minutes to adequately recover for the next performance set. Proper rest between sets should be maintained at approximately 1-2 minutes to recover sufficiently and promote the optimal muscle-building environment.

Cluster training involves sets with built-in, intra-set rest periods ranging from 10-30 seconds, which allows for more weight, reps and total volume lifted within a single set. For example, in the context of strength, instead of doing 4 sets of 6 repetitions, the athlete would perform 4 sets of 2.2.2 repetitions with 30 seconds of rest between each cluster. This allows for the same amount of volume in the first example, but the added rest within each set allows for heavier loads to be lifted, thus increasing the intensity of the exercise (O'Brien, 2009).

Frequency

It refers to the number of sessions per week. Protein synthesis—which is the process that builds muscle—can remain elevated for 48 hours or more post-training. With that understanding, you should allow at least 48 hours of recovery before hitting a given muscle group again. How you set up your training split becomes an important factor. Frequency exposure to hypertrophy stimuli 2-3 sessions per week for favorable protein synthesis.

Conclusion

Muscle hypertrophy is the increase of muscle mass, volume and strength on the other hand muscle atrophy is the decrease of muscle mass and strength which is leading to immobilization. In competitive sports, muscle strength is a prerequisite for success in any sporting event. Muscular hypertrophy plays a vital role and it can be increased through systematic training and nutrition adaptation of training load. For a desirable change in muscle, the mass athlete has to select appropriate multi-joint exercises, order or sequence of exercise, adequate volume, intensity of exercises, Frequency, tempo of exercises and adequate rest. Cluster training is found to be effective for muscular hypertrophy by several researchers. The present research article discussed various aspects of muscular hypertrophy for better sporting performance.

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