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Skeletal muscle function and adaptation to resistance exercise

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Abstract
Factors that influence the force producing capacity of normal muscle during an active contraction to the foundation upon which an understanding of how the neuromuscular system adapts as the result of resistance training. This study provides a basis on designing a resistance exercise program to improve muscle performance in person with weakness and functional limitations as the result of injury or disease or to enhance physical performance and prevent or reduce the risk of injury in healthy individuals.

Keywords: Skeletal, muscle, function, adaptation

Introduction

Factors that influence tension generation in normal skeletal muscle

Some factors affect the capacity of normal skeletal muscle to generate tension to the control the body and perform motor task.

Determinants and correlates include morphological, biomechanical neurologic, metabolic and biochemical factors. All contribute to magnitude, duration and speed of force production as well as how resistance or susceptible a muscle is to fatigue.

Energy stores, blood supply

Muscle need adequate sources of energy to contract, generate tension and resist fatigue.

Muscle contraction occurs cia metabolism of adenosine triphosphate drived primarily from the simple sugar glucose.

The predominant fiber type found in the muscle and adequacy of blood supply, which transports oxygen and nutrients to muscle and removes waste products, affect the tension producing capacity of a muscle and its ability to resist fatigue.

Fatigue

Fatigue is a complex phenomenon that affects muscle performance and must be considered in a resistance training program.

Muscle (local) fatigue: Muscle (local) fatigue is the diminished response of muscle to repeated stimulus and is reflected by a progressive decrement in the amplitude of the motor unit potentials. This occurs during exercise when a muscle repeatedly contracts either statically or dynamically, against an imposed load.

This acute physiologic response to exercise is normal and reversible. It is characterized by a gradual decline in the force producing capacity of the neuromuscular system, that is, a temporary state of exhaustion (failure), leadingto a decrease in muscle strength. The diminished response of the muscle is caused by a combination of factors which include.

- Disturbaces in the contractile mechanism of the muscle itself because of a decrease in energy stores insufficient oxygen, and a build-up of lactic acid
- Inhibitory (protective) influences from the central nervous system.
- Possibly a decrease in the conduction of impulses at the myoneural junction, particularly in fast-twitch fibers.

Physiologic Adaptations to Resistance Exercise

Factors	Influence
Cross section and size of the muscle (includes muscle fiber number and size)	The larger the muscle diameter, the grater its tension-producing capacity
Fiber arrangement and fiber length (also relates to cross-sectional diameter of the muscle)	Short fibers with pinnate and multipinnate disign in high force producing muscle (ex. Quadriceps, gastrocnemius, deltoid, biceps brachii) Long parallel design in muscles with high rate of shortening nut less force production (ex. Sartorius, lumbricals)
Fiber-type distribution of muscle: type I (tonic, slow-twitch) and type IIA & IIB (phasic, fast-twitch)	High percentage of type I fibers: low force production, slow rate of maximum force development, resistact to fatigue. High percentage of type IIA and IIB fibers: rapid high force production; rapid fatigue
Length tension relationship of muscles at times of contraction	Muscle produces greatest tension when it is near or at the physiological resting position at the time of contraction
Recruitment of motor units	The greater the number and synchronization of motor units firing. The greater the force production.
Frequency of tiring of motor units	The higher the frequency of tiring, the greater the tension
Type of muscle contraction	Force output from greatest to least: eccentric, isometric, concentric muscle contraction.
Speed of muscle contraction (force velocity relationship)	Concentric contraction: ↑Speed → ↓tension: Eccentric contraction ↑Speed → ↑tension:

Additional factors such as energy sores available to muscle, influence to fatigue and recovery from exercise and a person age, gender and psychological cognitive status as well as many

The fibber- type distribution of a muscle affects how resistant it is to fatigue. Type II (phasic, fast-twitch) muscle fibers, which generate a great amount of tension in a short period of time, are geared toward anaerobic metabolic activity and tend to fatigue quickly. Type I (tonic, slow-twitch) muscle fibers generate a low level of muscle tension but can sustain the contraction for a log time. These fibers are geared toward aerobic metabolism and are very slow to fatigue. For example, a heavy distribution of type I (tonic) fibers is found in postural muscles, which allows these muscles to sustain a sow level of tension for extended periods of time to hold the body erect against gravity of stabilize against repetitive loads. On the other end of the fatigue spectrum, muscles with a large distribution to type II (phasic) fibers produce a geat burst of tension to enable a person to lift the entire body weight or to lift, lower, push or pull a heavy load but fatigue very quickly.
Cardio respiratory (general) fatigue**:** This is the diminished response of an individual (the entire body) as the result of prolonged physical activity, such as walking; jogging, cycling, or repetitive lifting or diging. It is relsted to the body's ability to use oxygen efficiently. Cardiorespiratory fatigue associated with endurance training is probably caused by a combination of the following factors.

- A decrease in blood sugar (glucose) levels
- A decrease in glycogen stores in muscle and liver
- A depletion of potassium, especially in the elderly patient

Age
Muscle performance changes throughout the life span. With aging levels of ATP, CTP and myoglobin begin to decline reducing the muscles ability to function
Muscle fibers shrink or lost and surrounding connective tissue hardens making muscle contraction slower and more difficult
Exercise throughout life can help reduce the impact of aging by maintaining a healthy oxygen supply to the muscle.

Physiological adaptations associated with resistance exercise: when body systems are exposed to a greater than usual but appropriate level of resistance in an exercise program they initially react with a number of acute physiologic responses and then later adapt. Adaptations to overload create changes in muscle performance and, in part, determine the effectiveness of a resistanc to occur varies from one individual to another and is dependent on aperson's health status and previous level of participation in a resistance exercise program.

Neural adaption
In addition to the adaptive change that occurs in muscle fibers, resistance training also affects the influence of nervous system on the muscle. Neural adaptations are attributed to motor learning and improved coordination and in clued increased recruitment in the number of motor units firing as well as an increased rate and synchronizations of firing. It is speculated that these chances are caused by a decrease in the inhibitory function of the CNS, decreased sensitivity of the Golgi tendon organ (GTO) or changes at the myoneural junction of the motor unit.

Skeletal muscle adaptation
Muscle fiber adaptations caused by resistance training include increased cross-sectional areas of the muscle (hypertrophy, hyperplasia, or both) selective hypertrophy of fast twitch fibers, decreased or maintained mitochondrial number and capillary density of muscle and possible changes in energy sources.

Tendons, ligaments and connective tissue in muscles
Tendon transmits the forces produced by the muscle to the skeleton and therefore contribute to performance during various movements. However, increases in muscle forces e.g. due to training need to go in line with adaptations of the tendinous tissue to avoid impairments of tissue integrity and prevent injury. Tendons can adapt by change in the material and morphological properties leading to increase resistance of the tendon beginning in childhood to old age, but effective

mechanical stimuli and temporal dynamics of adaptation are different compared to the muscle. Consequently, periods of imbalanced muscle and tendon capacities can occur throughout a training period and may compromise optimal functional of the muscle tendon unit or affect tendon health.

Conclusion

Human skeletal muscle is often characterized as a mechanical device responsible for generating contraction force and movement. This review is aimed at highlighting the factors that influencing and contributing the health and activity of muscle tissue to resistance exercise and physiological adaptation elicited through resistance exercise. Regular exercise is an effective way to maintain health. It also results in various physiological adaptations in neuromuscular and cardio vascular systems in human body. These adaptations can improve physical performance.

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