Plyometric exercise is becoming a staple in the training regimens of all levels of athletes and coaches. Twenty years ago plyometric exercise was something mysterious that only a few daring athletes and unconventional coaches did. Today plyometric training has evolved into a widely accepted and greatly effective tool to improve power and agility. Athletes of all ages and skill levels can safely perform plyometric exercises. Once thought as only box jumping this training tool now encompasses so much more than “only” jumping around. Because of the success associated with plyometric training, strength and conditioning programs that incorporate this aspect of training are becoming more and more creative and complex.

History
It was not until the 1970’s that plyometric exercises or “jump training” began to gain popularity in the United States. Up until then, jump training was used primarily in eastern European bloc countries by the top athletes in sports like track and field, weightlifting, and gymnastics. A coach by the name of Veroshanski was among one of the first to publish a series of jumping drills. Originally the word “plyometric” comes from two Greek words, plio, meaning “more” and metric, meaning “to measure”, or more accurately “measurable increase.” The term plyometric was coined in 1975 by one of America’s great track coaches, Fred Wilt.

Muscle Physiology
Plyometrics trains the muscle to reach maximum force in as short amount of time as possible. The ability to combine speed and strength is what we refer to as power.
The body has many supportive and connective structures including bones, muscles, and tendons. Muscle fibers are constructed of myofibrils. Each myofibril is made up of a series of contractile units called sarcomeres; sarcomeres are the fundamental contractile unit of the muscle cell.

Muscular contractions that produce movement are called isotonic. Isotonic contractions can come in two forms, concentric and eccentric contractions. A concentric muscle contraction occurs when the muscle shortens against resistance and an eccentric contraction is the shortening of the muscle against resistance. An example of an eccentric contraction would be when the quadriceps muscles lengthen while contracting in order to decelerate the body after a run or on a landing.

**Neurophysiological Aspects of Plyometric Training**

The body also has proprioceptors, or receptors that are sensitive to tension and stretch. The muscle spindle is one of these proprioceptors and plays an active role in the stretch reflex. The stretch reflex is an involuntary response (contraction) to external stimuli that stretch the muscle (i.e. knee jerk reaction). In essence, when the spindle is stretched it sends out a signal to the spinal cord, which in turn sends a signal back to the muscle causing it to contract. The strength of the response of the muscle spindle is determined by the rate of stretch. Practically speaking this means the greater and more quickly a load is applied to the muscle, the more forceful the muscular contraction will be.

The Golgi Tendon Organ (GTO) is another proprioceptor located near the muscle-tendon junction and actually inhibits muscle contraction. The GTO protects against overloading and when it is stimulated it signals the muscle to relax. It may be that plyometric exercise can manipulate the threshold of GTO activation to maximize the elastic property of the muscle.

Each muscle fiber is innervated by a nerve, called a motor neuron, and the point where the nerve innervates the muscle fiber is called the neuromuscular junction (motor end plate). A motor neuron can innervate multiple muscle fibers, and the motor neuron and all the fibers it innervates are collectively called a motor unit. There are basically two ways to increase a muscle’s force production:

1) increase the rate at which a motor unit is stimulated, and/or
2) increase the number of motor units that are activated.

Plyometric training influences these two factors affecting force production and speed of that force production. Basically it is plyometric exercise that trains the neuromuscular system to respond more efficiently.

**Stretch-Shortening Cycle**

The stretch-shortening cycle (SSC) involves storing potential energy in a stretched muscle. Phase 1 of the SSC is known as the eccentric phase where preloading and stretching of the muscle occurs. During this phase the stretching of the muscle stimulates the muscle spindle. The muscle spindle sends out a signal that ultimately causes the muscle to contract. The second phase of the SSC is the amortization phase. Amortization (or transition) refers to the time period between the eccentric contraction and the resultant concentric contraction. Simply stated it is the time that elapses between landing and jumping again. The amortization phase is the most important phase and must be kept short. The longer the amortization phase the greater the loss of stored elastic energy. The third and final phase of the SSC is the concentric phase, where stored elastic energy is combined with the voluntary, concentric muscle contraction to contribute to provide the force necessary for the subsequent movement, or jump.

**Program Design and Basics**

Plyometric training is not merely doing a movement fast, but also at max effort. An increase in power can come one of three ways:

1) increase movement speed while maintaining strength,
2) increase strength while maintaining movement speed, or
3) increase speed and strength simultaneously.

Plyometric training takes a functional approach by incorporating speed and strength into common sports related movements. Repetitions and sets become secondary, because each plyometric movement is its own set and repetition, each one consisting of a maximal bout. Coaches may have athletes perform repetitive or back-to-back jumps, but it is important for the athlete to consider each jump its own set and repetition.

Intensity is paramount to successful plyometric training. Each exercise is performed at a maximal effort and intensity is determined by number of foot strikes or touches. For the elite athlete a high intensity plyometric workout may consist of about 200 – 400 touches or foot strikes. The beginning or intermediate athlete is in the range of 60 – 150 touches.

During short duration, high intensity exercises, such as plyometrics, the body uses the phosphagen system to provide the energy (ATP) needed for muscle contraction. Once ATP stores are depleted it takes time to resynthesize them. Approximately 70% of ATP is resynthesized after about 30 seconds and 100% after three minutes. Therefore, the rest periods used when performing plyometrics should be from 30 seconds to 3 minutes depending on the individual. If a maximal effort is demanded of each touch or foot strike, then it is important to allow for adequate rest between bouts is allowed.

Progression is vitally important. Athletes who have never trained plyometrically should meet certain strength parameters
before beginning. As a general guideline, athletes should not be allowed to perform plyometrics unless they can squat 1.5 – 2.5 times their body weight.

The progression through plyometrics should be intentional, beginning with basic movements like marching and skipping. Progress to activities like footwork and lunging drills, alternate movement drills (forward/backward) then on to jumping drills. Jumping drills should begin with standing jumps progressing toward bounding and then depth jumps.

Safe Progression of Plyometric Exercises
1. Marching and skipping drills
2. Footwork speed drills
3. Lunging drills
4. Alternate movements (forward/backward)
5. Jumping drills

Safe Progression of Jumping Drills
1. Standing in place jumps
2. Standing jumps
3. Multiple hops/jumps
4. Bounding/cone drills
5. Box/depth jumps

Precautions
The National Strength and Conditioning Association (NSCA) has released a position statement on Explosive/Plyometric Exercises that gives the following precautions.

1. As a rule, athletes weighing more than 220 pounds should not depth jump from a platform higher than 18 inches.
2. Surfaces for where plyometric exercises are performed should be resilient and have good shock absorbing qualities.
3. Plyometric training should not be performed on consecutive days or when the athlete is fatigued. Conventional wisdom says to have about 48 hours between plyometric sessions.
4. Depth jumps only be used by a small percentage of athletes engaged in plyometric training.

Obviously progression is also an important key. Too much, too fast, too soon is never a good idea. Take it slow and progress at a reasonable pace, introducing more complex jumps and greater intensities over time maximizing the benefits of plyometric training.

References

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