Introduction to Plyometrics: Converting Strength to Power

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Power, the combination of speed and strength, is crucial for success in many sporting events. The purpose of plyometric work is the same as that of strength training, to develop greater physical power. Many athletes spend all their time in the weight room trying to increase power with barbell and dumbbell exercises. While these exercises have their place, they are not the most efficient means of developing power. Traditional weight room exercises do not allow the athlete to move at the speed, or use the movements needed, to develop sport specific power.

While strength training can create the muscular and nervous system adaptations necessary for power development, plyometrics focuses on the speed component of power and transforms the physiological changes into athletic ability. It does this through the use of the elastic properties of muscle and the stretch shortening cycle.

The Stretch Shortening Cycle (SSC)

Muscles are capable of three types of contraction.

1. Isometric contraction in which the length of the muscle does not change
2. Concentric contraction in which the muscle is shortened
3. Eccentric contraction in which the muscle is lengthened

In normal activity, these contractions seldom occur alone. Due to the influence of gravity, compression and impact forces, from running and jumping activities, there is usually an eccentric contraction followed by a concentric contraction. This combination of eccentric-concentric contractions is known as the stretch shortening cycle. The addition of an eccentric contraction prior to a concentric contraction has been found to increase the force, speed, and power output of the concentric contraction.

Mechanisms Behind the SSC

The stretch shortening cycle results in more powerful concentric contractions. How does this happen? There are two mechanisms that help to contribute to the explosive concentric contraction these are the elastic potential of the muscle and the muscle spindles. The muscles contain elastic fibers made up of a protein called elastin. These fibers are easily stretched and return to their original length. They function similar to a rubber band and when stretched can add to the power of a movement. Since much of the original research into the SSC was done on isolated muscles fibers that had been removed from a frog, the elastic response was thought to be the main cause of the greater power output. However, the muscle spindle also plays a role when living muscles are activated.

Muscle spindles are located within a muscle near the point that it joins the tendon. A spindle consists of a modified skeletal muscle fiber with a sensory nerve wrapped around one end of it. The muscle spindle senses changes in the amount of stretch in a muscle. A signal is sent through the sensory nerve to the spinal cord where motor nerves are stimulated and the muscle that was stretched contracts. This is called the myotatic or stretch reflex. The most common example of this is the knee tap examination that doctors perform during an annual check-up. When tapping the knee, the patellar tendon and quadriceps muscle group is rapidly stretched. The quadriceps muscle group will react to this by contracting. An impulse is also sent to the antagonist muscle group inhibiting its contraction. During jumping activities the rapid stretching of the muscles on landing causes the spindles to be activated and thereby add to the power output. The spindles are sensitive to the rate of stretch, the more rapid the stretch the greater the activation level of the spindle. Since most natural movements will involve the activation of both the muscle spindle and the elastic components of the muscle, they both play a role in the increase in power output following SSC movements.

Plyometric Sequence

Plyometric exercises always follow the same specific sequence:

- A landing phase
- An amortization phase
- Take off

The landing phase starts as soon as the muscles start to experience an eccentric contraction. The rapid eccentric contraction serves to stretch the elastic component of the muscle and activate the stretch reflex. A high level of eccentric strength is needed during the landing phase. Inadequate strength will result in a slow rate of stretch and less activation of the stretch reflex.

The amortization phase, the time on the ground, is the most important part of a plyometric exercise. It represents the turn around time from landing to take off and is crucial for power development. If the amortization phase is too long, the stretch reflex is lost and there is no plyometric effect.

The take off is the concentric contraction that follows the landing. During this phase the stored elastic energy is used to increase jump height and explosive power.

Getting Ready for Plyometrics

Plyometrics are a very high intensity form of training, placing substantial stress on the bones, joints, and connective tissue. While plyometrics can enhance an athlete's speed, power, and performance, it also places them at a greater risk of injury than less intense training methods. Prior to starting a program there are several variables to consider so the training sessions are performed in a safe and effective manner.

Landing

As a general rule an athlete should not be jumping if they do not know how to land. A good landing involves the knees remaining aligned over the toes, the trunk inclined forward slightly, the head up, and the back flat (figure 1). When an athlete is learning to do plyometrics for the first time they should spend the first two to three weeks focused on landing and being able to move out of a landing before moving on to more intense drills.

Figure 1. Landing

Landing Surface

Plyometrics can be performed indoors or outdoors. The landing surface should be able to absorb some of the shock of landing. Gymnastic or wrestling mats are good indoor surfaces as are the sprung wood floors found in many aerobics studios. Outdoors, plyometrics are done on the grass or sand. Jumping on concrete or asphalt can lead to knee, ankle, and hip problems, as such these surfaces should be avoided.

Strength

Having a good strength base is essential for performing plyometrics safely and effectively. Without good lower body and core strength, the amortization phase becomes too long and much of the benefit of the plyometric is lost. Over the years, the need to squat one to two times body weight has been suggested as a requirement for plyometrics. While this is a good guideline for some of the higher intensity drills, simple jumps in place and hops over very low barriers can be used with most athletes as long as they have demonstrated the ability to land properly.

Injury History

Those athletes with a history of lower body injury must be full rehabilitated and have medical clearance prior to starting a plyometric program. The program should start with basic running and change of direction drills including cuts, corners, and rotations before moving on to higher intensity hops, throws, and jumps.

Designing a Plyometrics Program Intensity

Intensity is a measure of how hard you work, often compared to the maximum amount that you can do. Intensity is a factor in determining the overall stress a training sessions creates. As a power training technique, the speed of movement and power produced in each repetition of plyometric training determines whether or not you will get a training adaptation. All repetitions in a plyometric exercise are performed at maximum speed and power, anything less deceases the stretch shortening response and plyometric effect of the movement.

Contacts Per Session

Plyometrics are recorded by the number of single foot contacts with the ground. For example 80 contacts would be four sets of 10 repetitions with a two-legged type movement or a total of 80 steps with walking lunges. The volumes listed in table 1 represent the total number of contacts per training session, not the number of contacts per exercise. This table assumes that each movement is at 100% effort. Plyometrics performed at anything less than 100% do not get the benefit associated with rapid elastic force production. However, new plyometrics drill should be performed at 70% – 80% until you are comfortable and confident with the technique of the exercise.

Plyometrics should not be performed more than two to three times per week unless you are alternating days of upper and lower body plyometric drills. If you are just starting to incorporate them into your current conditioning program, two sessions per week is adequate.

Rest Between Sets

Rest and recovery are crucial variables in a plyometric program. Rest refers to the time that is taken between each exercise or set. Recovery refers to the amount of time that is needed before the workout can be repeated.

The amount of rest that is taken depends upon the duration of work and the type of drill or exercise used varying from zero to seven minutes between sets or exercises. Table 2 summarizes the duration of work and rest periods for a variety of work periods. In this table the work period refers to the period of continuous work and may not represent the total time for each set. In the case of single response drills, it is common to take five to ten seconds between repetitions to reset your body position, this can make the total time for the set quite long even though the continuous work time is very short, usually less than one second.

Sample Beginner Program

Table 3 contains a sample lower body program that is suitable for someone starting plyometrics. It is assumed that landing technique and body control are both good and that a dynamic warm up is done prior to the workout.

About the Author

Ed McNeely is a founding partner in StrengthPro Inc. A Las Vegas based sport science and nutrition business. He has been a consultant to 17 Canadian National and professional sports teams. Ed is the author of five books; The Resistance Band Workout Book, Power Plyometrics, One Hundred Strength Exercises, Training for Rowing, and Skillful Rowing, and has published over 100 articles on training and athlete conditioning covering topics such as strength training, plyometrics, making weight, assessing fitness, speed and power development, planning and periodization, and aerobic fitness.

Table 1. Foot or Hand Contacts per Session

Level	Low Intensity	Med. Intensity	High Intensity
Beginner	80	60	40
Intermediate	100	80	60
Advanced	140	120	100

Table 2. Work and Rest Periods

Work Time	Rest between reps	Rest between sets	Rest between exercises
< 1s	5 – 10 s	1 – 2 minutes	None
1 – 3 seconds	None	2 – 3 minutes	None
4 – 15 seconds	None	2 – 4 minutes	None
15 – 30 seconds	None	3 – 5 minutes	5 – 10 minutes

Table 3. Sample Beginner Lower Body Plyometrics Program

Exercise	Sets	Reps	Total Contacts	Rest Between Jumps	Rest Between Sets
Single response vertical jumps	3	5	30	5s	3 minutes
Hurdle Hops	3	4	24	No rest	3 minutes
Box jumps onto box	3	4	24	5s	3 minutes
Totals	9		78		

Plyometrics converts maximal strength into fast, powerful and explosive movements. Plyometric movements, or drills, are applied as sport-specific power by mimicking the movement patterns of the sport, which enables the athlete to run faster, hit harder, throw farther, react quicker, etc. Why are Plyometric Exercises Important for Injury Prevention? Plyometrics are often used by athletes to develop power for their chosen sport, and a lot has been written about how to accomplish this, but few people realize how important plyometrics can be in aiding injury prevention. Essentially, plyometric exe Vol. 6 No. 5 | Page 20. Introduction to Plyometrics: Converting Strength to Power. Plyometrics Injury History Those athletes with a history of lower body injury must be full rehabilitated and have medical clearance prior to starting a plyometric program. The program should start with basic running and change of direction drills including cuts, corners, and rotations before moving on to higher intensity hops, throws, and jumps. Introduction to plyometrics: Converting strength to power. NSCAâ€™s Performance Training Journal, 6(5), 19-22.[full text]. Ramirez-Campillo, R., Ãlvarez, C., GarcÃa-Hermoso, A., RamÃrez-VÃ©lez, R., Gentil, P., Asadi, A., & Sanchez-Sanchez, J. (2018).Â Postactivation potentiation of sprint acceleration performance using plyometric exercise. The Journal of Strength & Conditioning Research, 29(2), 343-350. doi: 10.1519/JSC.0000000000000647. Vossen, J.F., Kramer, J.F., Burke, D.G. and Vossen, D.P. (2000) Comparison of dynamic push-up training and plyometric push-up training on upperbody power and strength. J. Strength Cond. Res. 14(3): 248â€“253. [full text].