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Eccentric Jump Training for Volleyball
Re-Introducing the Depth Jump

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Introduction

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It happens all the time; we, as trainers and coaches, hear about the latest training 'secret' that claims that it can change the way that we train our athletes and will prove to be the key to enable training to transfer to court performance. However, in reality, I am here to tell you that the key may have actually been underneath our nose for a long time. This key that I am referring to is the principles and theories of eccentric training. The purpose of this article is to present a fresh look on a proven theory of training which suggests that the eccentric contraction that occurs at the plant of a jump, and the attainment of the mechanical and neuromuscular qualities important during this phase, may very well provide this key in the search for improvements in jumping and movement. This article will focus on how these theories relate to jumping performance however practitioners are encouraged to constructively think about how the principles can apply to the training of other very important volleyball skills.

Objectives in Training

There are many schools of thought that exist when it comes to optimally training volleyball players for increased jump performance. These schools of thought include but are not limited to; heavy resistance strength training, circuit training, bodybuilding-style training, Olympic-style weightlifting, and plyometrics. Traditionally, jump-specific strength training has long been centered on some form of weight-training combined with plyometrics (which can be termed Complex Training). And quite frankly, much success has been achieved through some combination of these philosophies of training. But a more detailed look into jump performance raises important questions: 1) are we missing anything with these philosophies? 2) is there a more specific way to train for jump performance? When we look at jumping (and other VB-specific skills), we know that an inherent objective for training must address a topic that we refer to as rate of force development (RFD).

Case in point; we know that most athletic tasks (including jumping and the hitting motion) usually take place over a very short time and distance. For example, an elite level outside hitter will only be on the ground for around 300ms during his/her approach. Thus, there is seldom enough time, on the court, to develop maximum force (which takes about 600-800ms). Therefore, there is a premium on generating the highest amount of force in the shortest amount of time. Thus, a fundamental objective will focus on training for concentric power production characteristics especially in regards to RFD. We can achieve that through many different training means that are beyond the focus of this article.

However, beyond that, another key concept (which can be argued to be more important than RFD attainment) to training for VB-specific jumping performance is the one of eccentric training. We know that the levels of force being absorbed by muscle and tendons while lengthening (as during eccentric contractions) is greater than those forces produced while shortening (as during concentric contractions). For example, if we use the example of the same outside hitter that we talked about above, during the limited time spent on the ground, the individual will be required to absorb up to 8 times one's bodyweight depending on certain variables such as landing position and approach speed. So, if this is not addressed in training, it can lead to jumping/movement inefficiency, or could be facilitated into a so-called non-contact injury. Therefore, along with the fundamental objective of improving concentric power production capabilities, we must also focus in on developing the eccentric strength needed to

tolerate the extreme power absorption that occurs while the body is explosively braking or while tissues are lengthening.

It is my suggestion that we, as trainers/coaches/practitioners, may very well need to re-think our training approaches to more specifically include ways to train for eccentric ability. I feel as though this ability is not only overlooked, but could also be the key trainable factor to having the greatest carryover to the actual sport movements found on the court.

The Stretch-Shortening Cycle

This argument is not necessarily a new one. In fact, in the late sixties, a Soviet Jump Coach and Sports Scientist named Yuri Verkhoshansky realized that the greatest jumping performances resulted from athletes who spent the least amount of time on the ground during their plant phase. From this analysis, he formed the hypothesis that in order for an athlete to be able to jump effectively, they must possess a high level of eccentric strength. This led him to develop the use of a number of exercises that he implemented to provide a 'shock' overload to the systems of the athlete. Originally termed "The Shock Method", these exercises have now come to be known as plyometrics. Of course, plyometrics have become a popular discussion point regarding increasing performance among American conditioning and volleyball coaches, alike. And maybe it's for good reason because when we look at jumping (or spiking and many other VB-related skills); we realize that it is a very plyometric-oriented event. Plyometrics can be defined as exercises aimed at improving the elastic/reactive qualities of strength and are exercises characterized by stretch-shortening cycle actions which enable muscles to reach maximum force in the shortest possible time. However, it should be noted that the term plyometrics was originally intended (by Verkhoshansky) to mean 'eccentric contraction'.

It is also important to get on the same page as to what the stretch-shortening cycle is. The stretch-shortening cycle (referred to from here on out as the SSC) is impulsive eccentric-concentric coupling where rapid deceleration via eccentric action is immediately followed by a transition/coupling phase (termed amortization) and acceleration in the opposite direction via concentric action. There are two models that exist to help explain the increased concentric power production seen during SSC movements; the mechanical and neurophysiological model. The mechanical model involves utilizing the elastic nature of the musculotendinous components, namely the series elastic component (SEC) to facilitate an increase in concentric muscle action. The other, the neurophysiological model, involves the potentiation (change in the force-velocity characteristics of the muscle's contractile components) of the concentric muscle action by use of the body's natural stretch reflex. This neurophysiological model is purely involuntary. Both then combine, through an impulsive three phase cycle to facilitate a maximal increase in force over a minimal amount of time. It has often been stated that the amortization phase is the key to ensuring the concentric power production is increased over those movements that are done from a static or pause position. However, it should be noted that if the eccentric phase is over too long of range of motion, or requires too long of time to execute, then the stretch reflex potentiation will be negated and the increased elastic energy will not be reutilized (instead it will be dissipated as heat) during the amortization phase and used to increase the concentric power production capabilities.

It is well-documented that the SSC contributes to increased jump height. However, the exact reasons that this results is still up for debate. Even though the SSC is very well researched, some things remain unclear about it, such as the degree to which model contributes to the overall increase in power production found within SSC movements and what influence eccentric pre-activity has. What is known is this; SSC actions involve many complex and interacting mechanical and neural processes and we must employ methods to train specifically to enhance these processes.

Eccentric Training Requirements

It has been stated by expert organizations, such as the National Strength & Conditioning Association (NSCA), that an athlete should be able to squat at least 1.5 times one's bodyweight before performing plyometrics in order to get the maximum amount of benefit from such exercises. However, we must remember that these original strength requirements are based primarily on the extreme loads that the Soviets were overcoming in their training (42+ inch depth jumps, etc). Thus, to overcome loads from those heights, one does have to possess a high level of overall force development capabilities.

But, it is my belief that these requirements are a bit over-stated. The sport of volleyball, as already alluded to, is plyometric in nature anyway so if we don't train for these appropriate loads in a controlled setting, how do we plan to play in an often uncontrolled one? Our athletes will be jumping and landing during the sport, so it my point of view that we should train the way we play because we are going to play the way that we train. In addition, many experts, including myself, often point out the fact that these recommendations are based on a quality of strength (max or limit strength) that is on an opposite end of the power continuum than the quality of strength (speed-strength or explosive power) that is needed to be proficient in the majority of eccentric-focused exercises. Thus, it seems almost useless to use these tests as ones to determine plyometric readiness.

Instead, I would point towards other variables as determinants of performing more shock-based eccentric work. These variables include such things as posture, balance, stability, and flexibility. It is obvious that these variables are more subjective, less measurable, and take greater coaching awareness but it is most useful during the execution of the movements suggested below. Coaches are encouraged to become very pro-active in the feedback given to athletes in regards to these variables.

Landing is Paramount!

Most people train only the taking off portion (concentric action) of jumping without working on the capacities to land and absorb (eccentric action). However, it can be hypothesized that how well one lands, will actually determine how well that same individual will take off. Thus, we must teach proper landings first for multiple reasons; 1) To ensure restitution of energy during the eccentric and amortization phases. 2) to allow for the greatest carryover to the sport. 3) to attain the fundamental base for proper exercise progression.

The pre-landing body position as well as maintaining posture, balance, and stability after ground contact is key. An athlete should learn to land on the balls of the feet (front two-thirds of the foot) with the ankle dorsiflexed (to the athlete is not on the toes) and with slight flexion at all major joints involved upon landing. The shoulders, knees, and toes should all be in alignment in this landing position. All of this in combination will allow for the quickest absorption rate, lowest ground contact time, and a more rapid recovery of potential energy which will make a more powerful concentric action more likely.

Specific Types of Exercises

If you accept these theories that a greater emphasis must be placed on improving eccentric strength capabilities, then it's time to look towards what types of exercises may be best for eliciting this result. Many practitioners have heard of the use of "negatives" during weight training. However, while this method definitely involves eccentric contractions, we must consider the concept of specificity and the attainment of volleyball-applicable characteristics. Negatives

involve a very slow lowering and stretching of the muscle (in some cases using load beyond one repetition maximum), whereas this almost never happens in a volleyball setting. Therefore, to assess the effectiveness of exercise selection, we must resort to exercises that are sport-specific as well as adequately overload the eccentric contraction mechanism to the extent required for our sporting movements. When we look at eccentric training for athletic performance, the purpose is not to necessarily increase eccentric tension and stress, but rather to build-up and utilize as much kinetic energy as we can.

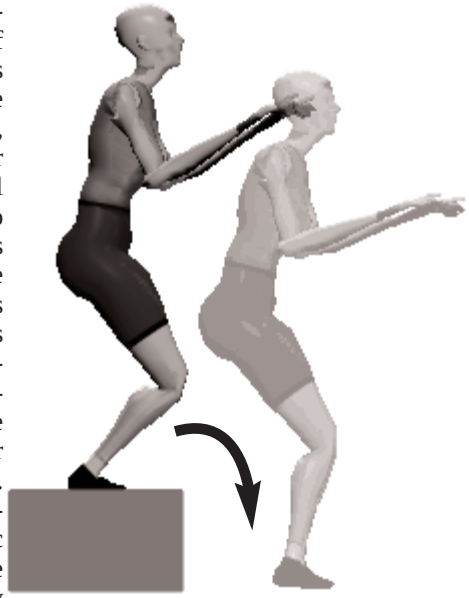

Figure 1

Altitude Landings

Most people train only the taking off portion of a jump without developing the capabilities for absorbing and stabilizing the forces to begin with. Thus, these athletes aren't able to develop force in the appropriate amount of ground contact time, without the capacities to control the degree of flexion. Therefore, there is an exercise that we can use to develop such capacities; the altitude landing (sometimes referred to as altitude shocks or drops). In the altitude landing an athlete stands on an appropriate box height and simply steps off the box and attempts to stick the landing (which refers to an athlete striving to immediately break the downward movement as soon as the feet hit the ground). However, the landing should be soft and silent. If done correctly, there should be a slight, involuntary reflexive bounce after impact. The most important objective in this exercise is to assume a joint position upon landing that is as close as possible to that of one's appropriate jump or sport action position. Essentially this exercise works to break the fall and absorb this energy and by doing so, one can greatly increase the body's ability to stabilize the forces being imposed upon it. The height of the drop should be regulated first based on the preparation level of the athlete but a good place to start is the height of an athlete's countermovement vertical or block jump (as long as an athlete does possess a sufficient training background). However, if the athlete is not effectively sticking the landing efficiently (the heels should not touch the ground), then the box height should be reduced to a height that enables one to absorb the most amount of energy without faltering. The coach can also require the athlete to hold the landing position for 3-5 seconds in order to bring in an isometric position and really concentrate on the ability to stabilize the negative forces from the landing (Figure 1).

Depth Jumps

Depth jumps was one of the original exercises (along with altitude landings) developed by Verkhoshansky as a shock method to develop the reactive ability/strength in athletes. Verkhonshansky believed that this exercise could truly bridge the gap between strength and speed. Depth jumps are done by executing the first part of an altitude landing but then immediately jumping up as high as possible after landing. It should be noted that depth jumps should never be done in training if when executing a depth jump, off of any height, the athlete cannot jump and reach a height higher than his/her countermovement vertical jump. Again, like in the altitude landings, one should strive to land in a position that is as specific as possible in order to ensure carryover to the court. The key to ensuring the effectiveness of depth jumps is keeping the amortization phase (measured through ground contact time) short enough to avoid losing the elastic energy produced during the stretching, but long enough to be at the appropriate time frame as found on the court. Thus, it is very important that the athlete find the correct execution in the most natural way and that the athlete doesn't think about it during the performance of a rep. The height should be regulated based on the training goal. According to Verkhoshansky, the use of depth jumps can be for the attainment of two separate specific strength qualities; lower drop heights can be used to develop the reactive capacities of the body and it doesn't depend on strength of the athlete. In contrast, higher drop heights can be used for maximal explosive effort. However, the degree of effectiveness with this style will depend on the muscular strength of the athlete. It is important to recognize that they are not training means with different training potential, but rather means with different training emphasis. Thus, it is essential for us, as coaches, to get it out of our heads that higher box height means more results as this is simply not the case (and this mindset can result in injury in our athletes). Before increasing box heights, we should strive to reduce ground contact time, increase jump speed/acceleration, and increase the height of the jump after landing (Figure 2).

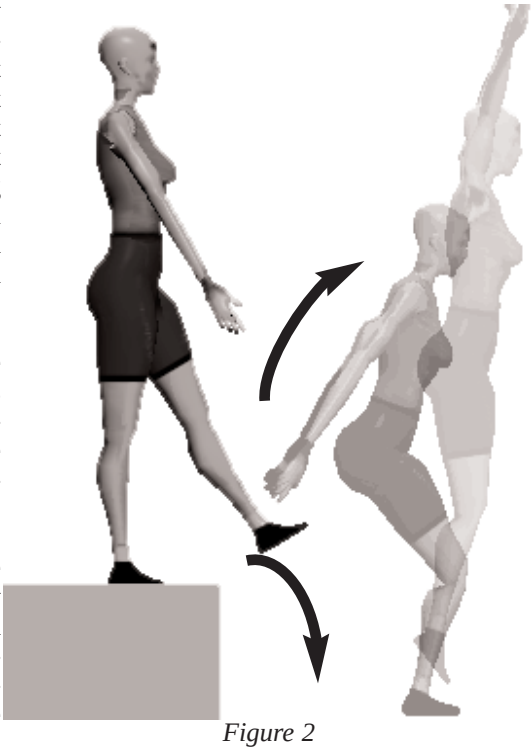

Figure 2

Overspeed Eccentrics

Just like with a countermovement jump, the faster you lower your body (and a bar on top of your shoulders) the more kinetic energy you produce and the faster you will go back up and increase power production. In addition, like with depth jumps, we are looking for a short amortization/transition time between eccentric and concentric movements here, as well. Another great way to increase the effects of overspeed eccentric exercises is to utilize bands for training in addition to bar weight. Using bands will have a positive effect because the bands will actually pull the bar down quicker than if just gravity was acting on it.

In addition to the greater kinetic energy being developed during this overspeed band work, another inherent benefit exists in that the accommodating resistance (seen with bands or even chains) requires the body to develop force with velocity in the fashion that it will occur when actually executing the movement (analogous to what occurs with the triple extension phase of jumping). In contrast, traditional strength training may actually inhibit this action as most forms of this type of training require the body to decelerate during concentric force application (which is opposite of what occurs during the triple extension phase).

Accentuated Eccentrics

Accentuated eccentrics involve the intentional, controlled acceleration of the eccentric phase of a movement where the load being resisted in

the eccentric phase is greater than that being overcame during the concentric phase (as in the use of weight releasers). This generates a large amount of force and also activates the stretch reflex. Research has demonstrated that an accentuated eccentric load can increase the maximum power developed in the concentric phase of the movement in comparison to the more typical training condition where the load lifted in the eccentric and concentric phase are equal. Studies have also demonstrated that using accentuated eccentrics evokes changes in jumping height and other important jump performance variables such as force, velocity, and power. We'll look at overspeed and accentuated eccentrics in the next issue of Performance Conditioning Volleyball.

Periodization and Prescription

The use of some exercises mentioned above (specifically shock training methods like the altitude landings or depth jumps), has been used for decades by coaches all across the world. However, prior to the point of its current popularity level, these forms of training were under much criticism due to its lack of a systematic approach to its use. But due to the work done by Verkhoshansky, and the success of Russian athletes in the late 1960's, coaches were given a glimpse as to how some of these eccentric-focused movements, in a cyclic nature, could result in very positive results for athletic performance.

Although no longitudinal studies of the proper periodization of eccentric-based work are found in research literature, there is some anecdotal evidence that exists. We can again look to the stages that Verkhoshansky implemented his protocols through a series of stages. The first stage consisted of developing overall physical preparation with included general strength and jumping techniques. In the second stage, plyometric work with increasing resistance and loads are included to prepare the body for the loads that it will incur during the specific tasks. In the third stage, involves the athletes will look to perform exercises that will focus on increasing the reactive ability (depth jumps).

Even though the methods mentioned above have a very powerful training effect, it is counter-intuitive to perform this type of training frequently throughout the year. The methods (shock methods in particular) should be used in short blocks of 3-4 weeks at a time with the same amount of time in between these blocks away from the exercises. In addition, some coaches and researchers recommend no more than 2-3 such blocks each year. Thus, it can be hypothesized and suggested that the blocks should be used when a rapid rise in power and reactive ability is required based on the sports season. It should also be stated that every training method will lose its effectiveness if used too much. All too often, because these methods are highly effective, practitioners will attempt to squeeze them into the overall training plan more often than is optimal.

Another problem is that coaches do not sometimes necessarily feel as though some of these methods are very tiring compared to other means of training so they often end up prescribing too great of volume throughout the training plan. However, because these methods involve a considerable amount of neuromuscular contribution, a different type of fatigue often becomes the reality for the athlete, and the whole body has a harder time actually recovering from it. Therefore, careful consideration should take place (but not necessarily completed avoided) if eccentric-focused work is prescribed in-season.

Reward vs. Risk

It must be emphasized that eccentric-focused work is an extremely high intensity form of training and should only be incorporated when proper progressions have been satisfied. As stated earlier, these exercises involved place a high amount of stress on the entire body including the muscles of the legs and joints at the hips, ankles, and knees. If done incorrectly, even the feet and backs of athletes can be put at risk. Thus, if the methods are used without proper progression or if used too frequently, the risks of this type of training can definitely outweigh any potential for performance improvement. If under the previously mentioned conditions, there are some injuries.

When proper progressions and sound guidelines have been adhered to, eccentric-focused work has been shown to be an effective method for improving vertical jump height, increasing power development, and reducing injury. However, to reiterate, athletes must be closely monitored and coached while incorporating these very intense methods.

Summary

This article attempted to offer greater insight into what could be looked at as a key to optimum movement on a volleyball court. The author implores volleyball coaches and volleyball conditioning specialists to take this knowledge and expand it to not only include the exercises that they are performing in the weight room and the court, but also to all other movements that are specific to the sport of volleyball. **O**

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