Shoulder Injury Prevention for Volleyball Athletes

Win Chang, M.D.
Fellow of American Academy of Orthopaedic Surgeons

Dr. Chang is a Board Certified Orthopaedic Surgeon with specialty in shoulder reconstruction and sports medicine. A graduate of the University of Rochester School of Medicine and Dentistry with Distinction in Research, he received further trainings at UCLA, NYU, and the Mayo Clinic. His patented invention of the unique rotator cuff exercise device, ShoulderSphere, was awarded the Gold Medal in Health and Fitness at the 2016 INPEX International Inventors Convention. Dr. Chang has given numerous lectures and seminars to physical therapists, athletic trainers, coaches, and athletes on rotator cuff management both nationally and internationally.

Dr. Win Chang, Founder of ShoulerSphere

The Problem

A well timed spike in volleyball is as awe inspiring as a slam dunk in basketball or a smash in tennis.

However, the price paid is that 40-60% of all competitive volleyball players have suffered shoulder pain at one time or another, and one in five of those injured athletes continue to play in

spite of shoulder pain. It is not uncommon for many athletes to have had shoulder surgery, even multiple times.

Overhead athletes, such as baseball pitchers, tennis players, and swimmers are all at risk for shoulder injury; volleyball players are no exception. Diagnoses such as “impingement”, “bursitis”, “tendinitis”, “labral tear”, “SLAP tear”, “hyperlaxity”, “instability”, and “rotator cuff tear” have become household terms. Serving, setting, blocking, digging, and spiking all involve repetitive overhead arm motion which cause tremendous stress to the rotator cuff muscles and tendons.

Functional Shoulder Anatomy

The shoulder, being the most mobile joint in the body, endows our ability to place our hands virtually anywhere in space. In exchange for this evolutionary trait of nearly unrestricted arm motion, by default, comes with increased shoulder instability. Unlike the very stable hip joint, the shoulder joint is not secured by a bony socket. This has been compared to as a golf ball (the humeral head) sitting on top of a “tee” (the glenoid). What then, protects the golf ball from tipping off the “tee”? — This is achieved via a specialized set of flexible “netting structure” surrounding the shoulder joint. The first layer of protection comes from a flimsy supple sac that encloses the shoulder - the capsule. The dish of the “tee” (glenoid) is further deepened slightly by a raised bumper-like rubbery material that circumferentially attaches to the periphery of this tee - the labral ligament. Covering the top of the golf ball, much like a hat, is a special set of tendons. These are the four rotator cuff tendons - one from the front of the shoulder, three from the back of the shoulder. These four tendons, although originate from four different muscles and different locations, essentially function as one muscle unit, working together in unison, to stabilize the shoulder joint when the shoulder moves from one direction to another. The rotator cuff muscle originating from the front of the shoulder, the subscapularis, is three times stronger than each one of the other three rotator cuff muscles originating from the back of the shoulder (supraspinatus, infraspinatus, teres minor). That is why it takes three in the back to balance out the one in the front. These four rotator cuff tendons are like legs of an octopus, flexible yet strong. Each leg must dynamically adjust to changes in direction as the shoulder moves, and stiffen up in accordance to which direction the shoulder moves. In order to ensure shoulder stability, all four muscles must contract synergistically in a balanced manner, with just the right amount of tension from each muscle, to keep the humeral head centered and abutted against the glenoid (the golf ball seated and centered on top of the tee) at all times during active shoulder motion. This is termed “glenohumeral joint compression”. Any imbalanced weakness from one of the “legs” of the rotator cuff tendon will lead to asymmetric compression, and will result in subtle wobble of the golf ball off the edge of the tee. This is “microsubluxation” of the shoulder. When repeated hundreds and thousands of times, such as in volleyball spikes and serves, the shoulder will be at risk for peripheral tearing of the labrum, shoulder impingement, bursitis, tendinitis, and tendon tearing.

Functionally, the rotator cuff muscles facilitate 3 aspects of shoulder activity — 1) arm moving to different directions, 2) arm acceleration, and 3) arm deceleration. Weakened, or imbalanced, rotator cuff muscles will result in pathological microsubluxation of the humeral head with each overhead movement. This causes asymmetric edge loading stress of the humeral head against the

rim of the glenoid. The overhead athlete will then eventually suffer from shoulder pain, labral tears, impingement tendinitis, bursitis, tendon fraying and even tendon tearing.

The Challenge Faced By Volleyball Athletes

Fast arm swing velocity is a prerequisite for successful volleyball performance. Male Olympic volleyball athletes can spike the ball 70 to 80 mph; NCAA males can spike in the range of 50-60 mph; high schoolers around 30-50 mph; and elite females can spike around 60 mph. The faster the arm whips, the faster and more imposing the spike. Because the point of ball contact is in midair with a jumping motion, all power must originate from the shoulder joint. Unlike the baseball pitch, where more than 70% of power is transferred from the ground up with the foot striking the ground creating a ground reactive force; the volleyball jump spike does not have the luxury of a ground reactive force to transfer power. The swing occurs in midair, both feet off the ground, with 100% of the power coming from the shoulder. Arm velocity is then predicated on a stable shoulder joint, which serves as the stable platform upon which the arm accelerates from, much like the runner pushing off from the starting block at the start of a 100 yard dash. The more stable the platform, the faster the acceleration. Shoulder stability, in turn, is dependent on rotator cuff engagement. Just like race cars, where the engine starts the process, but ultimately the performance rests on a set of good tires. Your rotator cuff is the tire to your race car. Since all power is delivered from the shoulder joint complex, this is exactly why those players who are at most risk for shoulder injuries are attackers and "jump" servers. Setters, defensive specialists, and "float" servers have less stress to their shoulders and, therefore, are at less risk for shoulder injuries.

The spiking motion is initiated by arm cocking, followed by rapid arm acceleration, and then rapid arm deceleration follow-through. With an arm spiking velocity approaching 80 mph, these movements are completed in under a tenth of a second. Just as in baseball pitching, biomechanical calculations of the spiking motion indicate that the rotator cuff can face a stress of over 400 lb force in under 1/10 second, all the while trying to keep the shoulder joint in place. What makes the rotator cuff exceptionally prone to injury is not just the power required, but the rapid adjustments needed responding to changes in directions of shoulder movement. Within milliseconds, the tendons must adjust to directional changes and stay engaged while the arm whips across sagittal, coronal, and transverse planes of motion. Ineffective and, or, inefficient rotator cuff engagement are causes for shoulder instability and causes for shoulder underperformance, shoulder pain, and shoulder injury.

How To Prevent Volleyball Shoulder Injuries

The single most important predictor for volleyball shoulder injuries is rotator cuff weakness. Consequently, the cornerstone for all shoulder injury prevention programs is to strengthen the rotator cuff. Traditionally these involve pulling elastic bands or lifting dumbbells. However, more important than to "strengthen" the four rotator cuff muscles, is to "train" how the four muscles function in unison to effect the desired movement. Therein lies the difference between "strengthening" and "training". Strengthening gets the muscle strong; training gets the muscle functional for a specific activity. Shoulder injuries among overhead athletes are secondary to

poor “motor control”, not “motor weakness”. Elastic bands and weights do “strengthen” the rotator cuff muscles; however they do not “train” for function of the activity at hand, such as spiking the volleyball. When the shoulder moves through multiple planes of motion, each rotator cuff tendon must be responsive to changes in shoulder direction, shoulder acceleration, and shoulder deceleration. The function of rotator cuff is to maintain shoulder joint stability throughout all ranges of shoulder motion. This can only be achieved by coordinated synergistic activation of all four rotator cuff muscles, just like a well orchestrated symphony, working together as one functional muscle unit. This “one” functional equivalent muscle unit exerts a constant and well balanced glenohumeral joint compression force through all planes of motions in order to ensure shoulder joint stability and to avoid shoulder injury.

The ShoulderSphere Technique

Rather than pulling rubber bands or lifting dumbbells in a “linearly” directed fashion in one of four “directionally” based movements - the push, pull, lift, or the press; ShoulderSphere (Figure 1) is the only rotator cuff exercise device in the world that strengthens and trains ALL four of the rotator cuff muscles simultaneously in a rotational manner. Linear movements only work on one muscle, one plane, and one direction at a time. These are nonfunctional and may result in imbalanced strengthening.

The use of ShoulderSphere involves active rotation of the ball inside the globe of the ShoulderSphere. When rotating the ball inside the globe in a circular motion, all surrounding muscles must work in a synchronized and balanced fashion in unison in order to to make this circular motion. Any rotator cuff shut down or imbalance will cause the ball inside the globe to drop and bounce rather than to rotate. Additionally, when using the ShoulderSphere, the user’s wrist is locked in the splint by the strap, all the work needed to rotate the ball must all come from the four rotator cuff muscles. The elbow only goes up and down. The wrist, being locked, cannot compensate to rotate the ball. Therefore, all the rotation must come from the rotator cuff.... the rotator cuff rotates. These features make ShoulderSphere the singular rotator cuff exercise device being the most selectively isolated rotator cuff workout of any technique available.

The Electronic Power Tracker

A unique feature of ShoulderSphere is the attached electronic power tracker (the blue box in Figure 1). This electronic tracker gives real-time display of the power of rotator cuff muscles during workouts. Green light equates to low power for endurance workout, red light equates to high power workout for high intensity interval training style exercises (HIIT).

The power tracker is activated by active spinning of the ball inside the ShoulderSphere. The DIRECTION of spin does not matter. Since this is "circular" training, as long as the ball spins, ALL rotator cuff muscles are engaged. The principle of ShoulderSphere workout is to maintain a continuous smooth spin of the ball inside the ShoulderSphere throughout the entire training session. Avoid allowing the ball to bounce, which signifies one or more of the rotator cuff muscles has been shut down, thus the chain of the circle has been broken.

THE POWER TRACKING LIGHT—

Fast spinning makes the power light turn on in red, lower power velocity spin changes it to green. A test, and means of tracking one's progress with strength improvement, is one's ability to maintain the tracker lit in red for 30-60 seconds continuously. This is high intensity interval training. Fun gauge regarding one's own progress. GREEN light can be thought of as endurance training; RED light as power training. Activity translational equivalents can be thought of as that when the power tracker light is maintained in red for 3 second using the larger ShoulderSphere (A7 model), it is equivalent to the rotator cuff engagement required for an arm velocity of 90

mph throwing a 5 oz baseball, or 50 mph spiking a 10 oz volleyball; with the light lit in green, it is equivalent to the rotator cuff engagement for an arm velocity of 60 mph throwing a 5 oz baseball, or 30 mph spiking a 10 oz volleyball.

Strengthening vs Training

ShoulderSphere can be used either as a pure rotator cuff strengthening device (in "static mode"), or as a training device (in "dynamic mode"). "Static mode" technique to strengthen the rotator cuff is performed by active rotation of the ball inside the globe without concurrent arm motion. "Dynamic mode" training technique is performed by moving the arm through various planes of motion while at the same time rotating the ball inside the globe (which actually also strengthens the rotator cuff muscles at the same time). Dynamic mode specifically trains the responsiveness of the rotator cuff muscles to adjust to the changing directions of multiplanar shoulder movements. All four rotator cuff muscles are trained to function as one muscle unit, not separately as four, to maintain glenohumeral joint compression at all times. This trains motor control and constant rotator cuff engagement for those ranges of motion. (the following video link demonstrates strengthening technique in "static mode" at various positions, also in "dynamic" mode where the arm moves through the motion of pitching a baseball —

https://www.youtube.com/watch?v=5cDhUslv4xA

https://www.youtube.com/watch?v=H6IJV9ebJDQ

Of particular importance among volleyball players is controlled rotator cuff engagement at end ranges of motion such as for events of jumping spikes and diving to get the ball up with one arm stretched out fully.

Training the Rotator Cuff For Athletic Shoulder Movements

Shoulder injuries among overhead athletes are due to poor "motor control", not "motor weakness". The ShoulderSphere rotator cuff motor control training method for athletic shoulder movements is performed by mimicking event-specific motor pattern movements of the arm that mirror the athletic motion involved, such as in spiking a volleyball. This "dynamic" motor control workout calls for active rotation of the ball inside the ShoulderSphere globe and with the arm mimicking the athletic pattern intended. The closer the mimicked motion that mirrors the activity intended, the more powerful will be the motor control training for rotator cuff responsiveness to stabilize the shoulder for that intend activity. This video link demonstrates motor control training of rotator cuff responsiveness for volleyball spiking moves via event simulation technique —-

https://www.youtube.com/watch?v=usb67dka_3k

This is training with intent.

ShoulderSphere is the most efficient and effective rotator cuff training device you will ever need. After all, it is not how hard you train, but how smart you train. Knowing why how you train, for what you train, makes all the difference in the world between a champion and everyone else.

Here is the link to the website for a 10-week progressive rotator cuff strengthening program for volleyball players —- https://www.shouldersphere.com/wp-content/uploads/2018/02/Volleyball-ShoulderSphere-Workout-Program.pdf

To learn more about ShoulderSphere and how you can integrate various strengthening and training techniques to suit your needs, please visit www.ShoulderSphere.com and follow us on Instagram @ShoulderSphere. Dr. Chang is also available to assist with any questions or special needs at Win@ShoulderSphere.com.