PERFORMANCE VOLLEYBALL CONDITIONING
A NEWSLETTER DEDICATED TO IMPROVING VOLLEYBALL PLAYERS

Postural Priorities-

Rib Cage Influences on Volleyball Attacking Mechanics

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Lisa was a member of the University of Nebraska volleyball team from 1995-1997. She was introduced to the science of Postural Restoration as a patient under the care of Ron Hruska. She had suffered from long-standing injuries sustained during her collegiate volleyball career and found success with the treatment techniques she learned at the Hruska Clinic and later received from the Postural Restoration Institute. Lisa returned to practice physical therapy at the Hruska Clinic Restorative Physical Therapy Services in Lincoln, Nebraska after completing her Doctorate of Physical Therapy from the University of Nebraska Medical Center in Omaha. Lisa is a member of the American Physical Therapy Association.

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Many volleyball athletes struggle to effectively master efficient attacking technique because the mechanics around the shoulder girdle they are attempting to use are faulty. In addition, there are those athletes that are hindered in their ability to compete and train because of chronic shoulder pain. Bicipital tendonitis, shoulder impingement, rotator cuff pathology, and labrum pathology are extremely common in competitive volleyball players. There are many etiologic factors that are commonly discussed in the orthopedic literature which include capsular laxity, soft tissue restriction of the posterior shoulder capsule, rotator cuff imbalance, and poor scapular mechanics. Of those factors, scapular mechanics receives a limited amount of attention, and when it is considered, rib position beneath the scapula is not considered. This discussion is part three in a series that has focused on rib cage biomechanics and the influence of the ribs on appropriate function of the shoulder. The first article introduced the concept of ribs directing the shoulder blade and provided an overview of rib cage mechanics and a brief explanation of the relationship between optimal diaphragmatic breathing and shoulder function. The second article discussed the rib cage and scapula mechanics needed for effective blocking. The purpose of this discussion is to demonstrate to the reader how rib cage and scapular position alters the biomechanics of humeral (arm) glenoid (socket) motion and rotator cuff function during the volleyball attack, and why suboptimal rib cage position, and lack of left diaphragmatic activity promotes faulty attacking mechanics and frequently precedes shoulder dysfunction and pain on the right side.

The angular velocity and joint compressive forces generated in the shoulder joint during the volleyball attack are tremendous. These forces should be created, absorbed, and dissipated not only by capsular restraints and rotator cuff musculature in the shoulder joint itself but also by appropriate synchronous interaction between the scapula, rib cage and pelvis. Although abdominal integration and pelvic stability play a significant role in optimal shoulder girdle function, it is beyond the scope of this article to include specific mechanical description of pelvis mechanics. For the purpose of this discussion, the volleyball attack has been divided into three rotator cuff phases; cocking phase, acceleration, and follow through.

During the cocking phase the superior and posterior rotator cuff muscles, supraspinatus, infraspinatus and teres minor, concentrically contract to position the arm in abduction and external rotation. Simultaneously the trunk is rotating to the right as the ribs on the right externally rotate and the scapula is being pulled into retraction and upward rotation by the posterior scapula thoracic stabilizers. The arm then begins to accelerate forward, to contact the ball, by strong concentric contraction of the internal rotators; primarily by the subscapularis, the anterior rotator cuff muscle, and secondarily by the latissimus and pectoralis. During humeral acceleration the trunk begins to rotate to the left as the right ribs now begin to internally rotate. During the follow through phase after the hand has made contact with the volleyball, the posterior rotator cuff decelerates the arm with eccentric activity, while the middle and lower traps, rhomboids, and serratus anterior continue to control scapular motion.

For the optimal rotator cuff and scapular mechanics that were just described to occur, as well as effective hitting ability, the athlete must have a scapula that is retained on the thorax, specifically lying over ribs two to seven. Atmospheric pressure, the weight of the arm, and correct muscular engagement by the trapezius, the serratus anterior, and the rhomboids are the physical and biomechanical strategies that retain the scapula on the thorax. The concave-convex relationship of the scapula on the thorax is essential for the scapula thoracic force couples to properly stabilize the glenoid during the volleyball attack and can only occur if the athlete is able to achieve and maintain a state of rib cage neutrality. In other words, their bony anatomical midline must be parallel with the frontal plane and the ribs must be in a state of neutral rotation. Rib cage neutrality enables appropriate rib rotation and trunk rotation to occur. Rib rotation not only provides the physiological means by which the lungs and thorax inflate and deflate during respiration, but also accompanies motion of the thoracic spine and provides the required convex surface for the scapula thoracic joint.

Many of the right arm dominant volleyball players that are treated and screened by the Postural Restoration Institute™, initially present with a spine and rib cage that is oriented to the right and compensating with upper trunk rotation to the left. Trunk rotation to the left positions the left ribs into external rotation and the ribs on the right into internal rotation. The reason for this predominant pattern is compensatory overuse of the left anterior interior muscular chain, as defined by the Postural Restoration Institute™, to stabilize the trunk and pelvis during repetitive right leg and hip function and repetitive right extremity use. The left diaphragm is one of several muscles in this chain that begins to function dyssynchronously. The primary function of the left diaphragm is to expand the lungs, especially the right apical lung. The left and the right diaphragms possess the greatest mechanical advantage for inhalation function when the left and right ribs are in internal rotation which is synonymous with trunk or spinal flexion. In this position the diaphragms are in a cylindrical domed-shape that can contract to externally rotate and elevate the rib cage thus increasing the volume of the thorax and lungs. The trunk reciprocally rotates to the left and to the right during normal gait. The right diaphragm is more effective for respiration when the trunk rotates to the left and vice versa. During upright gait the trunk should be reciprocally rotating, during which the diaphragm with the greater mechanical advantage continually alternates. When the trunk rotates to the right, which needs to occur during right cocking phase of the volleyball attack, the left ribs internally rotate. Upon left diaphragmatic contraction in this position, more of the inhaled air will go into the right apical lung because the volume increase is greater on the right side where the ribs are elevating and externally rotating. Full right lung expansion provides the required atmospheric pressure for optimal scapular position.

In addition to presenting with a rib cage that is not in a neutral resting state, in many right arm dominant volleyball players the right scapula is in a passive position of protraction. It may appear that the scapula is winging. The reason for this is because the thorax is essentially matched to the follow through position of the volleyball attack because the trunk is rotated to the left. Trunk rotation to the right can not occur during cocking phase if the athlete constantly remains in a state of trunk rotation to the left. The following pathomechanics must now occur for an athlete to attack the volleyball. With the right ribs internally rotated and the scapula passively protracted, the serratus anterior and lower and middle traps are not in a position to retract the scapula in conjunction with humeral abduction and external rotation. The upper trap is therefore heavily recruited to elevate the scapula via its clavicle insertion. The latissimus forces the thoracic spine into extension while the (short head) of the biceps, with its tendon in a lengthened position, pulls or helps elevate the arm. The infraspinatus and teres minor continue to work as the primary external rotators, but they have a tendency to become very short and tight because they are not sufficiently opposed by the anterior rotator cuff, the subscapularis. As acceleration phase begins, pure humeral internal rotation is impossible for two reasons; the subscapularis is incapable of engaging because the scapular position has severely decreased the mechanical advantage in its lengthened position and posterior superior humeral glenoid impingement does not allow for internal rotation in this thoracic scapular position. The latissimus is now recruited as a powerful internal rotator that has a more distal attachment on the neck of the humerus than the subscapularis. This leverage allows the humeral head to be pulled or translated forward as the lat internally rotates the arm, avoiding bony contact during the attack. Unfortunately repeated forward motion of the humeral head during the attack can begin to compromise the integrity of the anterior shoulder capsule. The overused shortened external rotators can compound this problem because as the infrapinatus and teres minor shorten and tighten, the associated posterior capsule can also become very restricted which further promotes anterior translation of the humeral head.

All right hand dominant athletes have tendencies toward the pathomechanics just described. Training strategies should emphasize correct asymmetrical trunk rotation and rib rotation before rotator cuff training is considered. Initial treatment and training strategy should focus on establishing and promoting left diaphragmatic function so that trunk rotation to the right is possible. Performing maximum exhalation, particularly against positive air pressure (balloon technique) is a great neuromotor retraining technique that can be used to restore synchronous diaphragmatic pumping by pulling the left externally rotated rib cage down into internal rotation (Figure 1). The diaphragm will now be in an optimal position for inhalation. Once diaphragmatic activity has been established, it can be integrated into activities that maximize active trunk rotation to the right, which mimics the mechanics required during the cocking phase of the attack (Figure 2, 3 & 4). In addition the serratus anterior and lower trap musculature needs to be trained in both active retraction and active protraction activities, with the latissimus inhibited, to promote controlled scapular motion during the volleyball attack (Figure 5, 6 & 7). Once rib cage position is appropriate and the athlete can rotate the upper trunk to the right during concomitant scapular retraction and upward rotation, the subscapularis can be trained to function as the primary shoulder internal rotator (Figure 8 & 9).

In summary of this third discussion, optimal rotator cuff mechanics during the volleyball attack are extremely dependent upon rib cage mechanics. Rib cage neutrality has been the reoccurring theme of these three articles. A neutral resting position of the thorax is the foundation for appropriate shoulder mechanics during competitive volleyball. All volleyball athletes, to some degree, are predisposed to postural discord and faulty rib cage mechanics because of right upper and lower extremity dominance. Pathomechanics at the shoulder girdle can be restored and prevented if training strategies demand appropriate diaphragmatic activity and trunk position.

More Information Please!

Please note that techniques provided in Figures 1 through 9 are only examples of the many non-manual Postural Restoration Institute™ techniques that could be considered appropriate for addressing the underlying biomechanical deficit described. For more information and references, please visit www.posturalrestoration.com.

PRI Wall Squat with Balloon - Figure 1

1. Stand with your heels 7-10 inches away from the wall.
2. Place a 4-6 inch ball between your knees and a balloon in your left hand.
3. Keeping your back rounded, begin to squat until your bottom touches the wall.
4. Once you are against the wall shift your left hip back. Your left knee will be slightly behind your right and you will feel your left outside hip engage.
5. Squeeze the ball between your knees and inhale through your nose. As you exhale reach forward and across the midline of your body with your right hand.
6. Maintaining the above position, inhale again through your nose this time slowly exhaling into the balloon.
7. Pause 3 seconds with your tongue on the roof of your mouth to prevent airflow out of the balloon.
8. Without pinching the neck of the balloon and keeping your tongue on the roof of your mouth, inhale again through your nose.
9. Slowly blow out again into the balloon as you also reach further across the midline of your body with your right arm.
10. Do not strain your neck or cheeks as you blow.
11. Inhale again through your nose. Slowly exhale into the balloon as you reach further with your right arm.
12. You should feel a stretch across your right chest wall. You will also feel your left abdominal wall and your left outside hip engaging.
13. After your fourth inhalation, pinch the balloon neck, remove it from your mouth and let the air out as you slowly stand up.
14. Relax your legs and repeat sequence 4 more times.

Sidelying Trunk Lift - Figure 2

1. Lie on your left side with your hips and knees bent at a 90-degree angle.
2. Prop your trunk up on your left forearm keeping your elbow directly below your shoulder.
3. Tighten up your abdominal wall and press your right knee down into your left.
4. Keeping your left shoulder blade down and back, slowly raise your hip up and off the mat. Your left abdominal wall and right inner thigh should begin to engage.
5. Raise your right hand up over your head and take 5 deep breaths in through your nose and out through your mouth.
6. Slowly lower yourself back down to the mat and repeat 4 more times.

Three Point Stance - Figure 3

1. Lie on your side and place your top leg in front of you and your bottom leg behind you.
2. Prop your trunk up on your bottom hand keeping your hand and trunk lined between your legs.
3. Tighten up your lower abdominal wall and upper inner thigh.
4. Slowly raise your hip and waist off the mat keeping your bottom abdominal wall and top inner thigh engaged.
5. Raise your waist line as high as you can before you place your top hand behind your head.
6. Hold this position as you take 4-5 deep breaths in through your nose and out through your mouth.
7. Slowly lower yourself back down to the mat and repeat 4 more times.

Standing Resisted Right Diagonal Flexion in PRI Right AIC Single Leg Vertical Balance - Figure 4

1. Place a piece of tubing underneath your left foot and place the other end in your right hand.
2. Shift your hips to the left and sidebend your trunk to the left.
3. Pull your shoulder blades down and together.
4. Begin to raise your right hand up and out to the side as you rotate your palm up. You should feel the muscles in the back of your right shoulder blade engage.
5. Lift your right foot in front of you.
6. Try to balance on your left leg as you reach forward and across the midline of your body with your left hand.
7. Hold this position while you take 4-5 deep breaths in through your nose and out through you mouth.
8. Relax and repeat 4 more times.

Paraspinal Release with Left Hamstrings - Figure 5

1. Place both of your palms on a 3-4 inch block and place your feet directly in front of you.
2. Pull your shoulder blades down and together.

3. Dig both of your heels into the floor and push down with your arms lifting your hips off the floor. You should feel the muscles on the back of your thighs and shoulder blades engage.
4. Once your hips are in the air, round your back by tucking your bottom up.
5. Continue to dig both of your heels into the floor as you move your hips slightly forward or away from the block.
6. Keeping your hips forward and your shoulders pulled together, pick your right foot off the floor. You should feel the back of your left thigh engage.
7. Hold this position while you take 4-5 deep breaths in through your nose and out through your mouth.
8. Relax and repeat 4 more times.

Bench Hooklying Thoracic Pull Ups - Figure 6

1. Lie on a bench with your knees bent and your hands gripping a bench press bar.
2. Pull your shoulder blades down and together.
3. Inhale through your nose and exhale through your mouth performing a pelvic tilt so that your tailbone is raised slightly off the bench. Keep your back flat on the bench.
4. Keeping your shoulder blades pulled down and your hips raised slightly off the mat, begin to pull your body towards the bar. Keep your back and neck straight with your trunk as you come up. You should feel the muscles in the back of your shoulder blades engage.
5. Hold this position while you take 4-5 deep breaths in through your nose and out through your mouth.
6. Relax and repeat 4 more times.

All Four Belly Lift Reach - Figure 7

1. Position yourself on your hands and knees with your hands on a 2-6 inch block.
2. Place your knees at shoulder width or slightly wider and round your back.
3. Maintaining a rounded back, raise your knees off the floor until your legs are straight.
4. Shift your weight to your right side and reach towards the floor with your left hand without bending your right elbow. You should feel the muscles in your shoulder blades engage.
5. Inhale through your nose filling up the back of your right chest wall with air.
6. Exhale through your mouth and reach or push with your left hand.
7. Place your left hand back on the block and shift your weight to your left side.
8. Reach towards the floor with your right hand without bending your left elbow.
9. Inhale filling the back of your left chest wall with air.
10. Exhale and reach or push with your right hand.
11. Continue this sequence of breathing taking 4-5 deep breaths in through the nose and out through the mouth while holding one position at a time.
12. Relax and repeat 4 more times with each arm.

Supine Resisted Right Tricep Extension with Right HG IR - Figure 8

1. Lie on your back with your knees bent.
2. Bring your arms to shoulder level and rest them on bolsters.
3. Bend both arms at a 90-degree angle.
4. Tie a piece of tubing into a knot and anchor it around a post directly above your right hand.
5. Place both hands inside the loop. The tubing should form a triangle.
6. Pull your shoulder blades down and together and turn both palms so that they are towards your feet.
7. Keeping your left hand stable, begin to straighten your right elbow against the resistance of the tubing. You should feel the muscles in the back of your right shoulder blade and the back of your right arm engage.
8. Maintaining the above position, begin to turn your right hand down towards the surface of the mat. You should feel the muscles in the back of your right shoulder engage.
9. Hold this position while you take 4-5 deep breaths in through your nose and out through your mouth.
10. Relax and repeat 4 more times.

Sidelying Trunk Lift - Figure 9

1. Lie on your right side with your hips and knees bent at a 90-degree angle.
2. Prop your trunk up on your right forearm keeping your elbow directly below your shoulder.
3. Press your left knee down into your right and pull your right shoulder blade down and back.
4. Keeping your right shoulder blade pulled back, slowly raise your right hip up and off the mat. You should feel the muscles in the back of your right shoulder blade engage.
5. Maintaining the above position, raise your left arm up above your head and take 4-5 deep breaths in through your nose and out through your mouth.
6. Slowly lower yourself back down to the mat and repeat 4 more times.

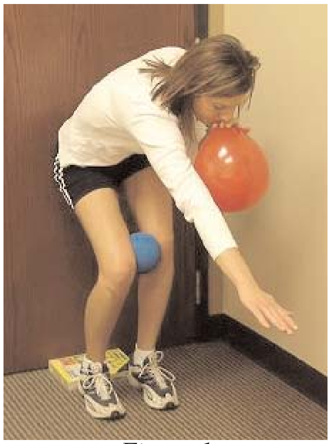
Figure 1


Figure 2


Figure 3

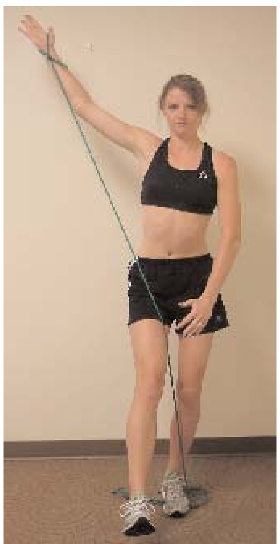
Figure 4


Figure 5


Figure 6


Figure 7


Figure 8


Figure 9