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Training the Shoulder Complex in Baseball Pitchers: A Sport-Specific Approach

Jeffrey J. Jeran, MS, CSCS
National Institute of Occupational Safety and Health Wellness Center, Morgantown, West Virginia

Robert D. Chetlin, PhD, CSCS, HFI
West Virginia University School of Medicine, Morgantown, West Virginia

summary

The purpose of this paper is to identify exercise performance-related factors which may contribute to shoulder pain and dysfunction and to describe appropriate training strategies for promoting shoulder stability and enhanced function. The intent is not to help the reader diagnose and treat injuries or to prescribe therapeutic interventions. Strength and conditioning professionals should encourage injured clients to consult a physician, physical therapist, or other appropriate health care professional before starting a conditioning program.

Introduction

The upper extremity is exposed to inordinate stress during a baseball pitch. Specifically, the overhand throw places considerable and varied load upon the shoulder complex. The rapid transition between eccentric (i.e., cocking phase) and concentric (i.e., acceleration phase) muscle actions during a baseball pitch produces extreme forces around the glenohumeral joint and greatly contributes to soft tissue microtrauma of the shoulder complex. The kinematics of a baseball pitch necessitates extreme range of motion (ROM) in the shoulder complex. Though the shoulder is well suited to accommodate great ROM, the sacrifice of strength and stability that is inherent in shoulder design produces a tenuous balance between elite performance and debilitating shoulder injury. This may be better understood when anatomically comparing the inverse relationship between strength/stability and ROM in ball-and-socket joints (i.e., shoulder and hip). That is, while the shoulder can produce great ROM, its architecture is inherently unstable (with reference to the humeral head in the shallow glenoid fossa). Conversely, the hip is quite strong and stable, yet lacks large ROM (with reference to the femoral head in the deep acetabulum). Thus, in order to perform pitching movements, the shoulder is exposed to an inordinate amount of stress it was not necessarily intended to handle. This anatomical paradox illustrates the thin line between accomplished performance and traumatic injury in both novice and experienced throwers.

A variety of shoulder injuries may result from exposure to the high forces associated with the baseball pitch (e.g., subacromial impingement, bicipital tendonitis, rotator cuff tendonitis, partial tear or rupture of the supraspinatus, labral tear, and tears of the superior labrum from anterior to posterior [SLAP]). Therefore, the purpose of this paper will be threefold: first, to describe the trauma associated with the rapid and forceful transition between the end of the cocking phase and the start of acceleration phase, when injury susceptibility is high; second, to account for the functional anatomy responsible for throwing competence; and third, to introduce some specific training modes designed to enhance kinematics (i.e., the description of the pitching motion without regard to the forces that produce the motion) of the baseball pitch. With regard to this latter purpose, we will also provide a

thorough training regimen for all portions of the shoulder complex that contribute to throwing dynamics.

Eccentric Loading: The Cocking Phase

The cocking phase is defined as the period of time between the beginning of the windup and the point at which the shoulder is in maximum external rotation. The cocking phase sets the body in position so all involved segments may contribute to the forward motion of the ball (24).

When the contralateral foot plants to initiate delivery the trunk rotates forward, and the shoulder reaches a position of approximately 90° abduction, 30° horizontal extension, and 90–120° of external rotation. The elbow is normally flexed to about 90°, and the wrist is in a slightly extended position. From the point of closed-chain contralateral foot plant to the subsequent throwing action, the time until release is typically quite similar for all pitchers (6, 28).

The cocking phase concludes when the shoulder and elbow are brought to a position of horizontal extension and the shoulder is externally rotated to approximately 160°. Shoulder complex rotation during windup is not limited strictly to glenohumeral rotation but rather includes a composite motion consisting of glenohumeral rotation, scapulothoracic rhythm, and trunk extension. Various authors have determined that maximum shoulder external rotation during this phase ranges from 160–185° among professional pitchers (5, 6, 20, 28). There is no forward movement of the ball in the cocking phase, except when the contralateral foot plants and forward trunk rotation begins (i.e., transition).

Explosive Concentric Contraction: The Acceleration Phase

The acceleration phase begins with the throwing shoulder in the position of maximum external rotation (i.e., at the end of the cocking phase) and terminates with rapid release and acceleration of the ball toward the plate. The internal rotation of the shoulder in the acceleration phase can be described as one of the most explosive human movements in sport (5). The transfer of energy from the lower extremity to the rotation of the core, combined with the upper extremity, results in the extreme velocity seen in the acceleration phase (21).

There are 4 components, occurring transitionally from external to internal rotation, that lead to ball release. Specifically, these forces lead to maximum velocity. First, the shoulder is explosively internally rotated. Ball release occurs between 40 and 60° of external rotation. Second, as the shoulder is internally rotated, the elbow flexes from 90° to approximately 120°. The elbow rapidly extends to a position of 25° of flexion 30 to 40 milliseconds before ball release. Third, 20 milliseconds before ball release, wrist flexion begins from a position of extension and ends in a neutral position (i.e., ball release). The wrist does not flex beyond neutral until the ball is actually released. Finally, radioulnar pronation begins 10 milliseconds before ball release, with the forearm pronated to approximately 90° at release (i.e., for a fastball) (3, 24). Pronation is a normal mechanism for most pitchers throwing various types of pitches (3, 5, 8, 24, 28).

Consequences

Precise coordination of the upper extremity muscles is necessary to generate sufficient force and assure sound technique to avoid injury. The chronic stress of pitching can lead to a variety of injuries to the shoulder. Some of the maladies associated with the cocking and acceleration phase include subacromial impingement, bicipital tendonitis, and anterior instability (12).

If the abducted arm is not properly positioned by the serratus anterior and the upper and middle trapezius, internal impingement and anterior instability can occur within the glenoid (12). The great ROM needed to throw a baseball can lead to laxity of the static stabilizers (capsular ligaments and labrum). The dynamic stabilizers (supraspinatus, infraspinatus, subscapularis, teres minor, and the long head of the biceps) must be somewhat flexible in order to maximize ROM. There is a thin line between necessary flexibility for performance and pathologic laxity, which can lead to increased local stress and injury (21).

In the late cocking phase, the anterior shoulder muscles can sustain limited microtrauma from maximal external rotation and horizontal extension. Anterior translation (i.e., partial loss of joint integrity) of the humeral head in the glenoid may result from repetitive microtrauma to the static stabilizers. With the repetitive trauma of throwing, stresses from extremes of eccentric muscle contraction can lead to microtears at myotendinous attachments. Anterior instability may result from failing support of the dynamic as well as static stabilizers (16).

When the static stabilizers become fatigued, recruitment of the rotator cuff muscles increases, which may lead to anterior translation and impingement (12). In the late cocking phase, when the arm is abducted and maximally rotated externally, an anterior subluxation may cause direct contact between the humeral head and the posterosuperior glenoid rim. When this happens, the posterosuperior rotator cuff tendons and labrum become pinched between these 2 structures, thus leading to internal impingement syndrome (12, 14, 17, 27). Impingement syndrome may be classified as primary (i.e., mechanical compromise of the subacromial space, including spurring) or secondary (i.e., functional impairment associated with glenohumeral or scapulothoracic instability). Though

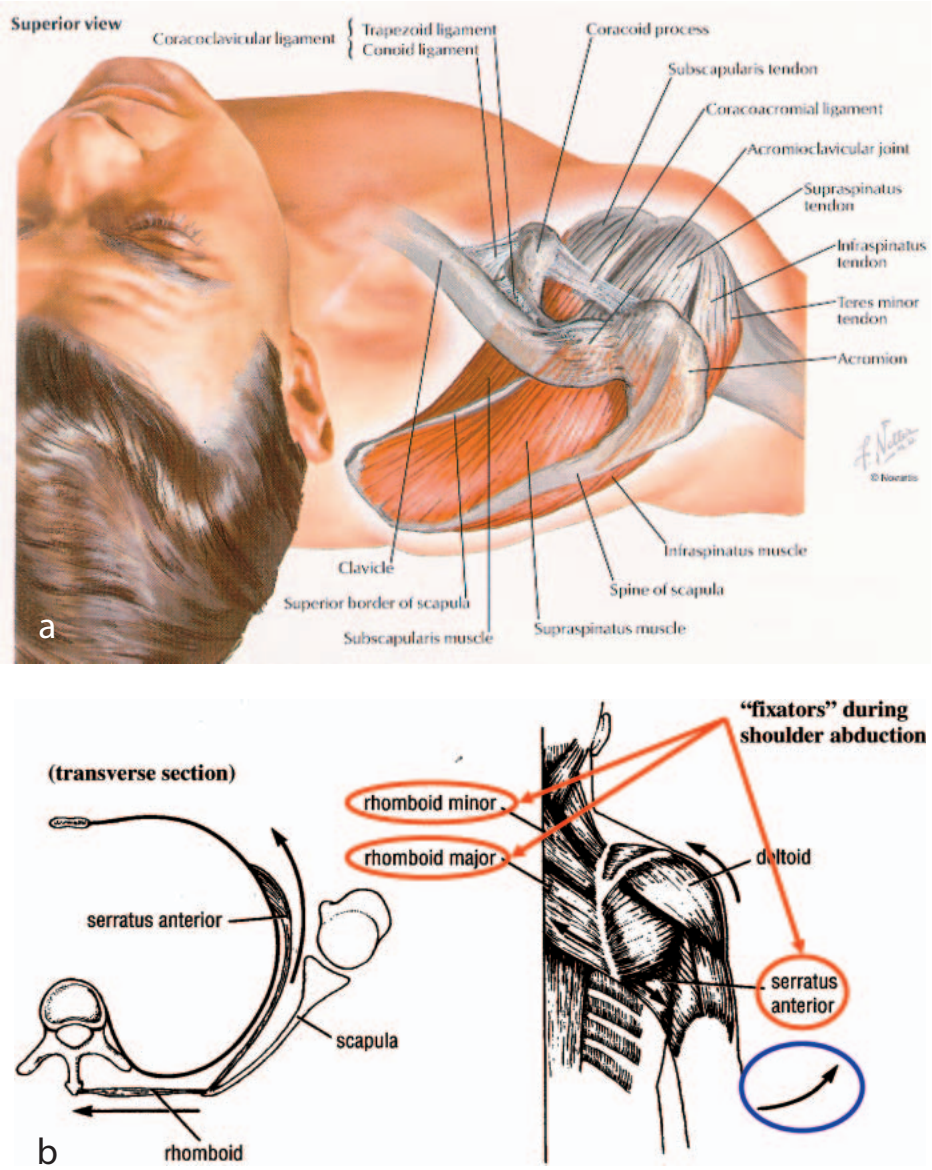

Figure 1. (a) Superior view of the shoulder complex and arrangement of the rotator cuff (22). (b) Shoulder complex muscles "fix" scapula, permitting normal overhead activities (26).

pitchers may experience either variety, internal impingement—in this case, posterior superior impingement—is most often associated with overhand throwers (15).

Internal impingement can coexist with various forms of shoulder injury, such as fraying of the biceps tendon, which may be a result of anterior subluxation. In the unstable shoulder, the action of the long head of the biceps is increased due to elbow eccentric deceleration or as an adjunct to shoulder stabilization (10). Itoi and colleagues (10) speculated that "the long head of the biceps is more important than the rotator cuff muscles as stability from the capsulolabral complex decreases." Damage and inflammation to the long-head bicipital tendon from repetitive trauma may lead to bicipital tendonitis. Affected pitchers may, therefore, complain of pain over the anterior aspect of the shoulder. This may lead athletic trainers to speculate that bicipital tendonitis is the culprit (11).

Spurring of the inferior surface of the acromion from overuse leads to a narrowing of the subacromial space and impingement syndrome, particularly in older throwers (12). In the acceleration phase, mechanical compression of the supraspinatus insertion is caused from this narrowing of the subacromial space (12). The narrowing may contribute to tearing or rupture of the supraspinatus tendon, possibly leading to early termination of the athlete's career (12). Internal impingement may also affect the posterior insertion of the infraspinatus on the greater tuberosity of the humerus and origin of the long head of the biceps on the supraglenoid tubercle. Internal impingement is worsened by the thickening and fibrosis of the subacromial bursa, which may be caused by repetitive throwing, inflammation, and overuse (18, 29).

Functional Anatomy

Several muscle groups contribute to the coordinated action of the baseball pitch. From proximal to distal these include the shoulder fixators, shoulder extensors/flexors, shoulder rotators (internal/external), and elbow extensors/flexors. The rotator cuff muscles greatly contribute to dynamic stabilization as well as acceleration and deceleration of the glenohumeral joint during throwing (5, 13, 14). Figure 1a shows the muscles of the rotator cuff, and Figure 1b illustrates the associated movement of the shoulder complex.

In the early cocking phase (or windup), the serratus anterior and trapezius are recruited. Impingement can occur if the serratus and trapezius do not position the glenoid appropriately. The scapula is rotated upward and protracted to keep the glenoid in position. This position allows the middle deltoid and supraspinatus to efficiently abduct the arm. The supraspinatus provides fine adjustments to the humeral head, but

the middle deltoid provides most of the force for abduction (9, 16). The supraspinatus protects the glenoid by stabilizing the humeral head from excessive translation (i.e., anterior subluxation) (4). The static stabilizers of the shoulder and inferior glenohumeral ligament limit anterior and posterior translation of the humeral head when the humerus is abducted to 90° or more (1).

The opposing influence of the scapular protractor (serratus anterior) and retractors (trapezius, rhomboids, and levator scapulae) permit smooth external rotation of the humerus in the late cocking phase (4, 16). Actions of the pectoralis major and minor, latissimus dorsi, biceps brachii and subscapularis also add anterior and posterior stability to the glenohumeral joint and shoulder girdle (10, 19, 23). Action of the deltoid diminishes as the rotator cuff muscles increase activity during the late cocking phase. The infraspinatus and teres minor are responsible for the major external rotation observed during this phase. The supraspinatus is the least active of all the rotator cuff muscles during the late cocking phase (7, 9).

In the acceleration phase, the glenoid fossa of the scapula acts as the fulcrum for the explosive torque that accompanies this phase. The major muscles that contribute to the observed forces of the acceleration phase are the powerful adductors/internal rotators of the shoulder, namely the pectoralis major and latissimus dorsi (16, 17). The subscapularis guides the humeral head in the glenoid, much like the supraspinatus in the cocking phase, and prevents the subluxation of the humeral head during explosive internal rotation. The teres minor limits the humeral head from posterior translation by allowing movement in the capsule when the shoulder is at maximum external rotation and extension, which can occur when the shoulder is cocked (15). As the humerus is internally rotated, the posterior deltoid is positioned to horizontally extend the arm during the early part of the acceleration phase (15, 18, 25).

Injury Prevention and Performance Enhancement: The Case for Activity-Specific Exercises

The act of pitching conforms to specific laws and principles that govern movement. Newton's second law, the law of acceleration, states that

> "the rate of change of momentum of a body is proportional to the applied force and takes place in the direction in which the force acts" (2).

In other words, the acceleration of an object depends on its mass and on the amount of applied force, and, therefore, objects with less mass are easier to move and will move before heavier objects they may be attached to. Normal arm abduction is possible because the mass of the scapular fixators is greater than the deltoid, thus causing the arm to move in the expected direction. If the scapular fixators were paralyzed by a denervation injury, for example, then attempted abduction of the shoulder would result in an awkward rotation of the scapula (which would move first because it is less massive) and not shoulder abduction. Scapular kinematics is, therefore, an important consideration for competent pitching motion, according to the law of acceleration, because weak scapular fixators may adversely affect arm strength (via insufficient scapular stabilization) and accuracy (via unwanted scapular movement).

Inappropriate scapular kinematics may be further illustrated by the biomechanical principle of levers. Throwing a baseball involves third-class lever action, where the glenohumeral joint acts as the fulcrum, the baseball acts as resistance opposite the axis, and the muscles responsible for delivery are located between the fulcrum and the resistance. Imagine that your arm, shoulder, and scapula form a type of catapult (a classic third-class lever), where the scapula forms the base (i.e., the fulcrum or axis), the shoulder, upper arm, and forearm provide the desired muscle action (i.e., the effort), and the basket (i.e., the hand) holds the ball (i.e., the resistance). If the scapula or base is weak, or not tightly fixed, and you have the strongest arm in the world, the law of acceleration assures that your unstable base (i.e., scapula) will be difficult to control, resulting in improper mechanics, inaccurate throwing, poor velocity, and increased susceptibility to injury. Therefore, we believe that a strong base (i.e., the scapular fixators) is vital to both skilled performance and injury prevention. The scapular fixators, therefore, should be trained as diligently as those muscles that are directly involved in accelerating the ball.

In our experience, many training programs for pitchers overemphasize strengthening the rotator cuff muscles, overlooking the fixators of the scapula. The exercises presented at the end of this paper are specifically directed at not only improving performance, but also protecting the shoulder complex from repetitive or traumatic injury. We will also discuss the training variables of mode, intensity, frequency, and duration for both rotator cuff and scapular fixation exercises.

There are 2 fundamental applied training principles that must be understood before prescribing shoulder exercises. First, the principle of sport specificity necessitates that exercise training should approximate, as closely as possible, the movements associated with the sport in question. Unfortunately, some exercise professionals may fail to do an activity analysis on the sport, which leads to the same exercises prescribed for the

Figure 2. Traditional (a) external rotation and (b) internal rotation exercises. Note: Based upon our professional experience and unpublished observations that poor posture (e.g., forward head and shoulders) is a factor in the creation of shoulder problems, we advise paying particular attention to head and neck posture with each exercise to develop improved posture. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder-width apart with a slightly staggered stance, whenever possible. See Figure 3 for correct standing position.

Figure 3. Suggested posture for standing exercises. Head, shoulders and back are held in slightly extended position, with knees comfortably flexed, feet approximately shoulder-width apart, and stance moderately staggered.

general population being directed toward the thrower (2). For example, traditional internal and external rotation of the glenohumeral joint, with elbow held tightly to side and motion in a transverse plane about a vertical axis (Figures 2 and 3), has few, if any, sport-specific implications for throwing a baseball. However, this exercise certainly has clinical benefit as a means to strengthen the internal and external rotators of the glenohumeral joint.

Second, the specific adaptation to imposed demand (SAID) principle implies that the body will adapt to the demands of the training stimulus but will not adapt beyond the scope of that stimulus. For example, endurance training programs will not produce gains in strength (2). The complexity of the shoulder joint dictates a multifaceted training approach, which includes (a) training targeted to agonist, antagonist, and fixator muscles, (b) training that emphasizes strength and power, (c) resistance exercise performed in the planes and about the axes of motion associated with the intended activity (consider that many conventional shoulder exercises are not always performed in activity-specific planes, and that the rotator cuff should be trained in affiliated planes of motion), and (d) an emphasis on improvement in concentric, eccentric and isometric strength. The literature indicates that excessive eccentric loading (especially of the supraspinatus tendon) is strongly correlated to rotator cuff injury (18, 27). We emphasize that shoulder training modalities should utilize combinations of concentric, eccentric, and isometric muscle actions.

Medicine Ball Shoulder Training Exercises (Table 1)

Applied Simulated Throw (Figure 4)

This exercise is performed in transition ROM (i.e., transition from eccentric loading to concentric muscle action). While holding a baseball-sized medicine ball or a specialized medicine ball, assume throwing position at end of cocking phase (i.e., shoulder extended and abducted, elbow flexed,

Table 1
Medicine Ball Training

Exercise	Targeted muscles	Safety considerations
Applied simulated throw (Figure 4)	Internal and external rotators	Simulated throwing motion should be performed in a very deliberate and controlled fashion; it is advised that the abbreviated motion transitioning from eccentric (i.e., late cocking phase) to concentric (i.e., early acceleration phase) muscle actions be performed with a 2- or 3-s count.
Medicine ball snatch (Figure 5)	Upper trapezius, anterior deltoid, rhomboids, levator scapulae, supraspinatus	Exercise should be performed with strict control, especially during eccentric phase; hold ending position by isometrically contracting the scapular retractors for 1–2 s.
"Pop" drill (Figure 6)	Anterior deltoid, coracobrachialis, and long head of biceps	Maintain upper arm position parallel to the ground in a parasagittal plane throughout movement; maintain elbow flexion of 120–130 during drill, with palm in elevated and pronated position. Wrist should be held in approximately 30 of extension.
"Power pops" (Figure 7)	Anterior deltoid, coracobrachialis, long head of biceps, and finger flexors	Utilize the safety considerations of the "pop" drill.
Self pass (Figure 8)	Supraspinatus, infraspinatus, and teres minor	Elbows should be flexed to 90 and held tight to the torso; fingers should be slightly flexed to maintain control of the ball. Perform the external rotation portion of the movement in a very controlled fashion.
"Around-the-world" (Figure 9)	Internal and external rotators	Exercise must be performed in very deliberate and controlled fashion (i.e., 3–4 seconds to complete 1 revolution). Utilize a solid base of support with knees slightly flexed, feet approximately shoulder width apart with a concurrently staggered stance; head, neck, and back should be maintained in slightly extended position.

Figure 4. Applied simulated throw: (a) eccentric loading to (b) concentric action.

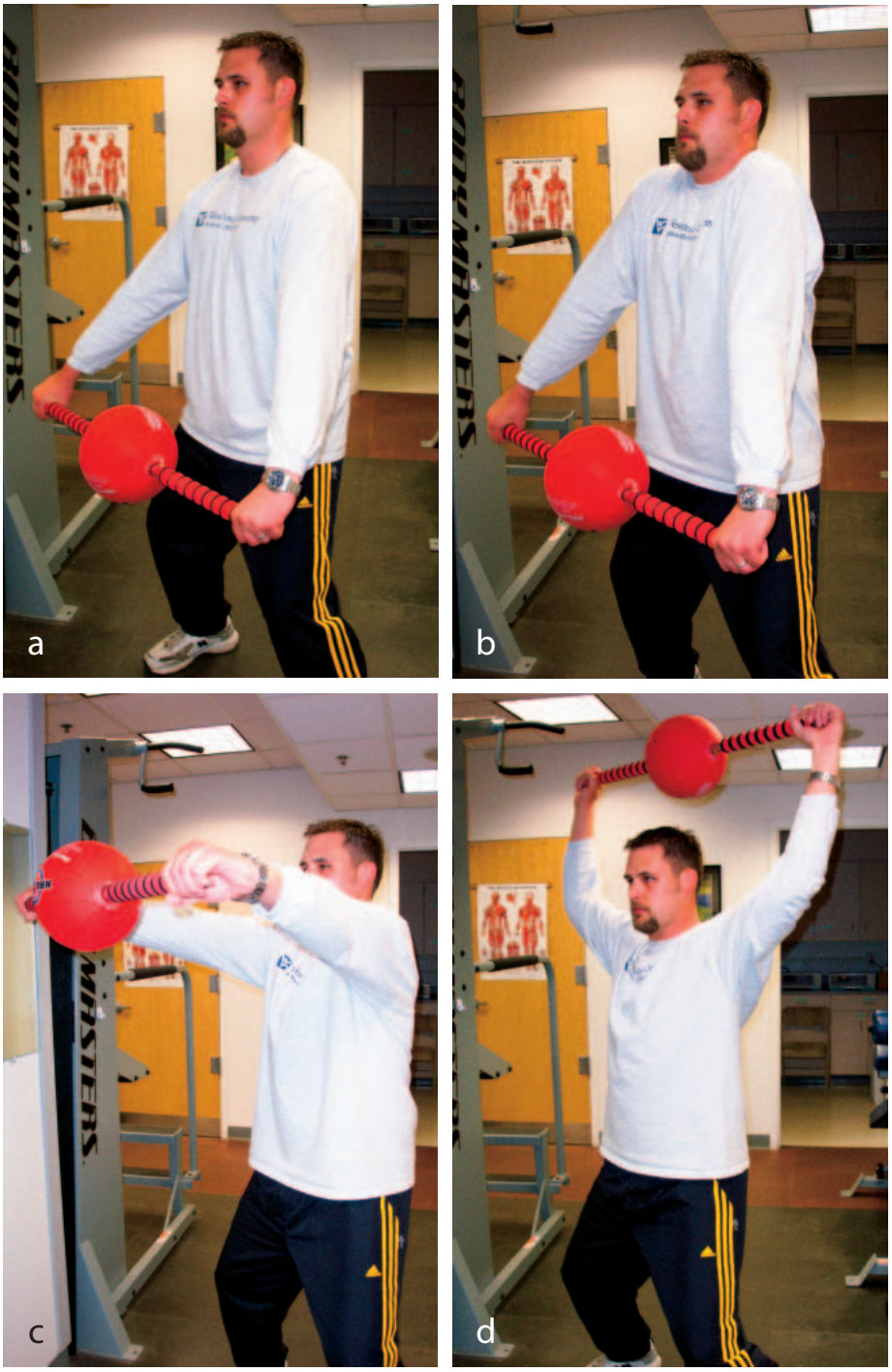

Figure 5. Medicine ball snatch: (a) starting position; (b) initial pull; (c) ball elevation; (d) ending position.

and wrist slightly extended). Move the resistance through a small (approximately 6 inch) ROM, alternating between eccentric and concentric phases of throwing motion.

Medicine Ball Snatch (Figure 5)

This exercise is similar to a conventional snatch; however, ball elevation should be controlled. Flex shoulders to elevate ball until movement past head puts shoulders into extended lock-out position. At this point, utilize an isometric muscle action to retract the scapulae. Return the ball to the starting position with a very deliberate eccentric action, and repeat.

"Pop" Drill (Figure 6)

With a small medicine ball in the palm, flex the shoulder with the upper arm parallel to floor. Flex the elbow until the supinated palm is directly superior to the shoulder. Next, flex the shoulder to facilitate a slight release (i.e., a few inches of movement) from the palm. Catch the ball and repeat while holding the upper extremity in static position. The pop drill is intended to target the shoulder flexors. The exercise should be performed in a rapid, yet controlled, fashion in a parasagittal plane.

"Power Pops" (Figure 7)

Assume the same position as described for the pop drill, but instead of using shoulder flexion to facilitate ball release, use both shoulder and finger flexion to pop the ball out of the hand, then catch and repeat.

Self Pass (Figure 8)

Flex both elbows to about 90° (Figure 8a) and pronate the palms until they face the midline. Holding this position, toss a small medicine ball back and forth between each hand (Figure 8b). To incorporate an external rotation component, allow the shoulders to rotate laterally after catching the ball. Repeat.

"Around-the-World" (Figure 9)

With medicine ball extension handles held in a vertical position in front of the face, rotate the ball in a transverse plane about a vertical axis in alternate clockwise and counterclockwise fashion. Hands should alternate between superior and inferior positions with each rotation.

Manipulation of the Training Variables

- *Frequency.* 2–3 days on, 1day off.
- *Intensity (Time per Set).* 15 seconds,

Figure 6. "Pop" drill: (a)starting position; (b) ball release.

Figure 7. "Power pops": (a) starting position; (b) explosive "pop."

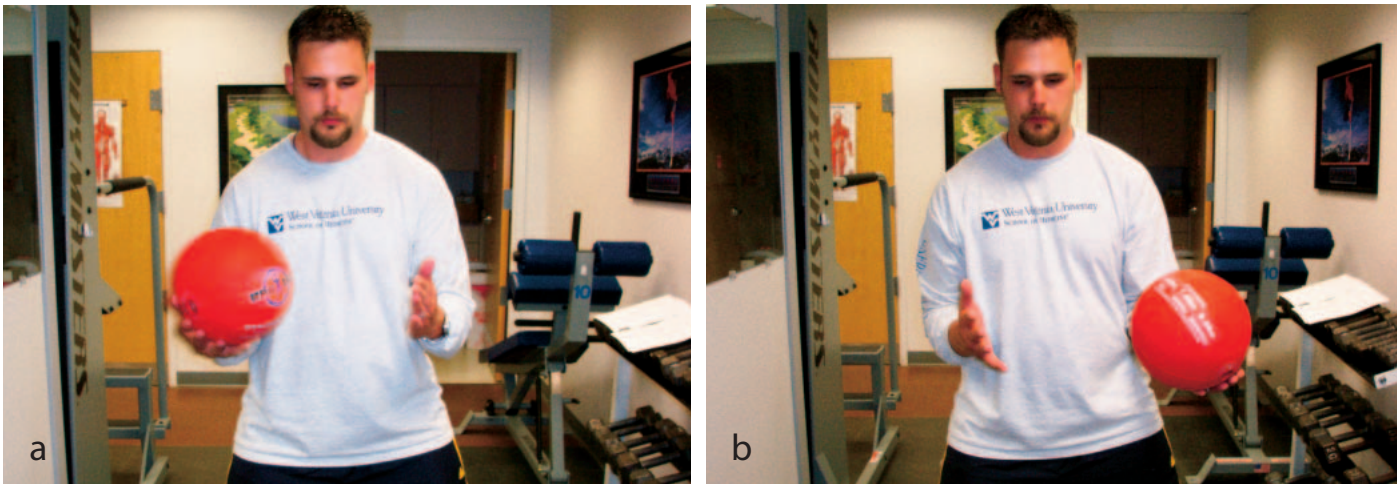

Figure 8. Self pass: (a) starting position; (b) tossing motion.

Figure 9. "Around-the-world": (a) starting position; (b) clockwise rotation; (c) continued rotation; (d) ending position.

30 seconds, 45–60 seconds. The use of time (seconds) instead of repetitions allows for continuous repeated effort each time as opposed to a traditional volume (sets ¥ repetitions).

- *Progression (Volume and Frequency).* Begin with one 15-second set of each exercise, 1 day on, 1 day off; progress to three 45- to 60-second sets, 2–3 days-on-1-day-off.

Table Top and Wall Exercises (Table 2)

Scapular Protraction/Retraction (Table Top; Figure 10)

To Strengthen the Scapular Protractors and Retractors. While seated beside the table, place a hand on the table with the elbow straight. Slide the hand and arm forward by moving your scapula into protraction. Next, slide the hand and arm backward by moving your scapula into retraction. Keep your shoulder level; do not allow it to rise closer to your ear. Maintain upright head and neck posture throughout the exercise.

Scapular Elevation/Depression (Table Top; Figure 11)

To Strengthen Scapular Elevators and Depressors. While seated beside the table, with the shoulder abducted and elbow in full extension, slide hand backward into elevation and foreword to depression. One must concentrate on depressing the scapula during this exercise.

Scapular Protraction/Retraction, (Wall; Figure 12)

To Strengthen the Scapular Protractors and Retractors. Stand with your finger tips on the wall in front of you at a comfortable height, but no higher than shoulder level. Keep your elbows straight and move both of your shoulders so your scapulae move into protraction, and then move them back into retraction. Hold the retraction position for 6 seconds. Maintain good upright head and neck posture throughout the exercise.

Scapular Elevation/Depression, 1 (Wall; Figure 13)

To Strengthen Scapular Elevators and Depressors. Stand with your fingertips on the wall in front of you at a comfortable height, but no higher than shoulder level. Keep your elbows straight and move both of your shoulders so your scapulae move into retraction. Keep them in retraction and then move them into elevation and then into depression. Hold the depression position for 6 seconds.

Table 2
Table Top and Wall Exercises

Exercise	Targeted muscles	Safety considerations
Scapular protraction/retraction: table top (Figure 10)	Serratus anterior, rhomboids, and upper, mid, and lower trapezius	Maintain upright head and neck posture throughout the exercise. Opposite hand should be placed behind head.
Scapular elevation/depression: table top (Figure 11)	Upper trapezius, rhomboids, levator scapula, lower trapezius, pectoralis minor, and lower serratus anterior	Maintain upright head and neck posture throughout the exercise. Opposite hand should be placed behind head.
Scapular protraction/retraction: wall (Figure 12)	Serratus anterior, rhomboids, and upper-mid-lower trapezius	Maintain good upright head and neck posture throughout the exercise. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder width apart.
Scapular elevation/depression: wall, 1 (Figure 13)	Upper trapezius, rhomboids, levator scapula, lower trapezius, pectoralis minor, and lower serratus anterior	Maintain good upright head and neck posture throughout the exercise. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder width apart.
Scapular elevation/depression: wall, 2 (Figure 14)	Upper trapezius, rhomboids, levator scapula, lower trapezius, pectoralis minor, and lower serratus anterior	Maintain good upright head and neck posture throughout the exercise. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder width apart.
"Thumbtack" exercise: Wall (Figure 15)	Upper trapezius, rhomboids, levator scapula, lower trapezius, pectoralis minor, and lower serratus anterior	Maintain good upright head and neck posture throughout the exercise. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder width apart.
"No money" exercise (Figure 16)	Restore scapular flexibility	Maintain good upright head and neck posture throughout the exercise. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder width apart.

Figure 10. Scapular protraction/retraction: (a) starting position; (b) protraction; (c) retraction.

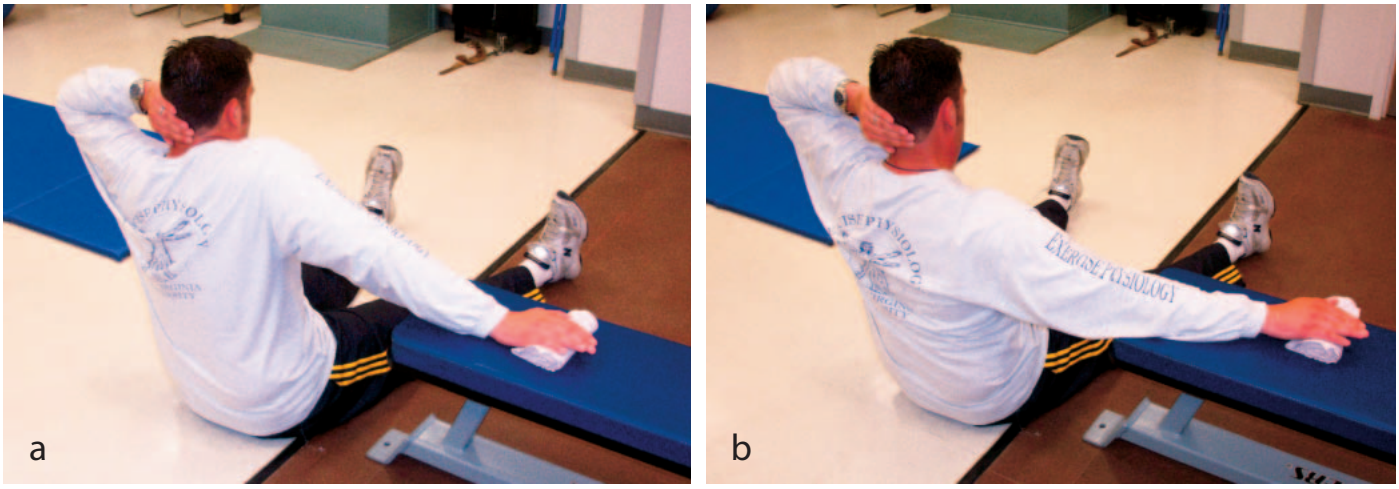

Figure 11. Scapular elevation/depression: (a) scapular elevation; (b) scapular depression.

Figure 12. Wall exercise for scapular protraction/retraction: (a) scapular protraction; (b) scapular retraction.

Figure 13. Wall exercise for scapular elevation/depression: (a) scapular elevation; (b) scapular depression.

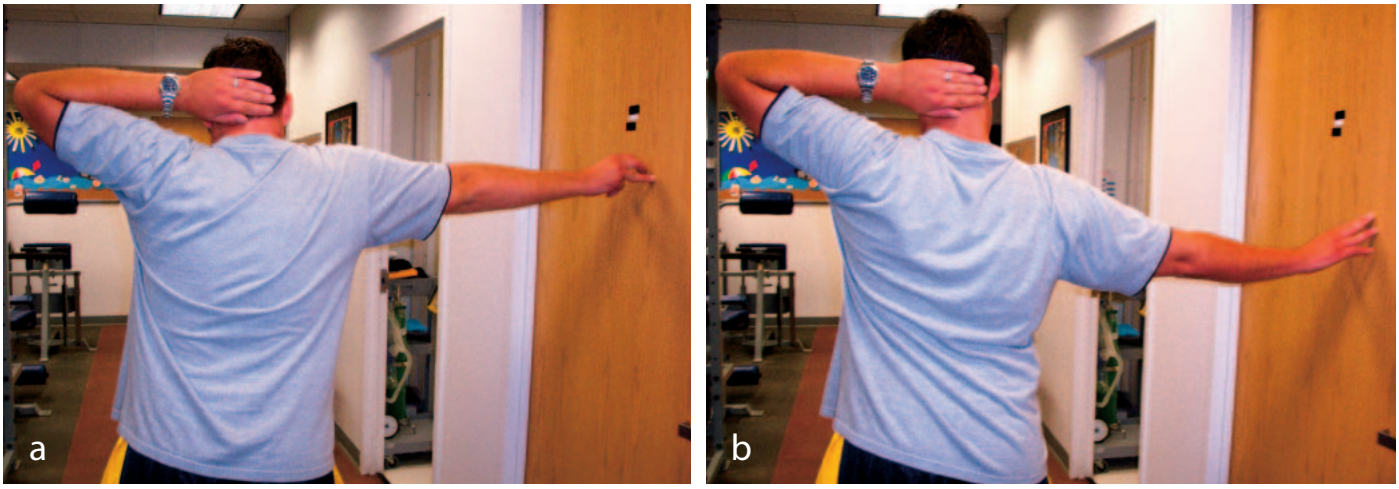

Figure 14. Wall exercise for scapular elevation/depression: (a) scapular elevation; (b) scapular depression.

Figure 15. Wall "thumbtack" exercise: (a) internal rotation and elevation; (b) external rotation and depression.

Scapular Elevation/Depression, 2 (Wall; Figure 14)

To Strengthen Scapular Elevators and Depressors. Stand with the fingertips of one hand on the wall beside you at a comfortable height, but no higher than shoulder level. Place the opposite hand behind your head with the elbow in line with your head and the scapula in retraction. Move the scapula of the hand on the wall into elevation and then down into depression. Hold the depression position for 6 seconds.

"Thumbtack" Exercise (Wall; Figure 15)

To Restore Scapular Flexibility and to Strengthen Scapular Elevators and Depressors. This is a wall exercise for scapular elevation/depression and shoulder internal/external rotation. Place your thumbs on the wall in front of you in a comfortable position, but no higher than shoulder level. Keep your elbows straight and rotate your arms using your thumbs as pivot points (as if you were screwing a thumbtack into the wall). Be sure to rotate the arms fully in each direction to the extreme so that the shoulders rise (scapular elevation) and lower (scapular depression) with the extreme positions of rotation. Keep your head and neck in good postural alignment.

"No Money" Exercise (Figure 16)

To Restore Scapular Flexibility. Lie on the floor or on a table, or stand with your back against the wall. Bend your elbows and raise your hands to elbow level, keeping your elbows against your side. Move into scapular retraction and move your hands toward the floor or wall by rotating the shoulders. Keep your head in a good postural position. Hold the final position for 10 seconds and then relax and return to the starting position. Maintain good upright neck and head posture during the exercise.

Figure 16. "No money" exercise: (a) starting position; (b) retraction/external rotation.

Table 3
Standing Compound Movements

Exercise	Targeted muscles	Safety considerations
Lateral lunge (Figure 17)	Upper and lower trapezius, pectoralis minor, serratus anterior, rhomboids, and levator scapula	Safety considerations are the same for all 4 exercises. Maintain good upright head and neck posture throughout the exercise. Head and shoulders should be slightly extended, back held in a slightly extended position, knees comfortably flexed, and legs shoulder width apart.
Forward lunge (Figure 18)	Serratus anterior, rhomboids, and upper, mid, and lower trapezius	
"Lawn mower" pull (Figure 19)	Rhomboids, upper, mid, and lower trapezius, serratus anterior, levator scapula, and pectoralis minor	
"4-Count" exercise (Figure 20)	Upper, mid, and lower trapezius, rhomboids, levator scapula, lower trapezius, pectoralis minor, and serratus anterior	

Manipulation of the Training Variables

- *Frequency.* 2–3 days on, 1day off. (The exercises should be performed before practice or game warm-up.)
- *Intensity (Repetitions per Set).* 10–12 repetitions, 1–2 sets.
- *Progression (Volume and Frequency).* Begin with one 10-repetition set of each exercise, 1 day on, 1 day off; progress to three 12 repetition sets, 2–3 days on, 1 day off.

Standing Multi-Muscle Movement Exercises (Table 3)

Lateral Lunge (Figure 17)

To Strengthen Scapular Depression/Downward Rotation and Elevation/Upward Rotation With the Large Arc Shoulder Motion. Begin by standing with your hands on your chest. Take a stride to the right, moving the right hand in a low sweeping motion that continues up and above the head, ending overhead. This movement causes the scapula to move down and then up, resulting in elevation and upward rotation. Return to the resting position by following the same path of the hand back to the chest. This movement results in scapular depression and downward rotation. Repeat the same motion with the left hand and return to the starting position. Keep the head and neck in good postural alignment throughout the exercise.

Forward Lunge (Figure 18)

To Strengthen Scapular Protraction With the Forward Stride and Retraction With

the Backward Stride. Begin by standing with your hands on your chest. First, stride forward with the right leg and reach forward with the left hand, keeping the left elbow at shoulder level. Next, stride back with the right leg so it lands well behind the left leg and move the left arm back so the elbow finishes behind the left shoulder at shoulder level. Repeat these movements for the prescribed number of repetitions, and then repeat the movements for the left arm, stepping with the right leg. Keep your head and neck in good postural alignment.

"Lawn Mower" Pull (Figure 19)

To Strengthen Scapular Depression/Protraction/Downward Rotation on the Downward Movement and Scapular Elevation/Retraction/Upward Rotation With the Upward Movement. Begin by standing with your hands on your chest. Squat at the knees and hips, keeping the back straight, and touch the outside of the right knee with the left hand. Stand up and move the left elbow above and behind the left shoulder, keeping the chest facing forward. Repeat with the right hand touching the left knee.

4-Count Exercise (Figure 20)

To Strengthen Scapular Depression, Elevation, Protraction, and Retraction. Begin by standing with your hands on your chest. First, squat at the knees and hips to move the left hand down to touch the outside of the left knee, keeping the back straight and the chest facing forward. Next, stand up and move the left elbow behind the left shoulder. Move the left elbow and hand across the chest just below the chin, and then move the left elbow back to position 2. Repeat the 4 movements for the assigned number of repetitions. Repeat the process for the right shoulder.

Manipulation of the Training Variables

- *Frequency.* The exercises should be performed after bullpen work and after pitching in a game.
- *Intensity (Repetitions per Set).* 10–12 repetitions, 1–2 sets.
- *Progression (Volume and Frequency).* Begin with one 10-repetition set of each exercise, and progress to two 12-repetition sets. Use cuff weights, starting with 2 lbs and progressing from there.

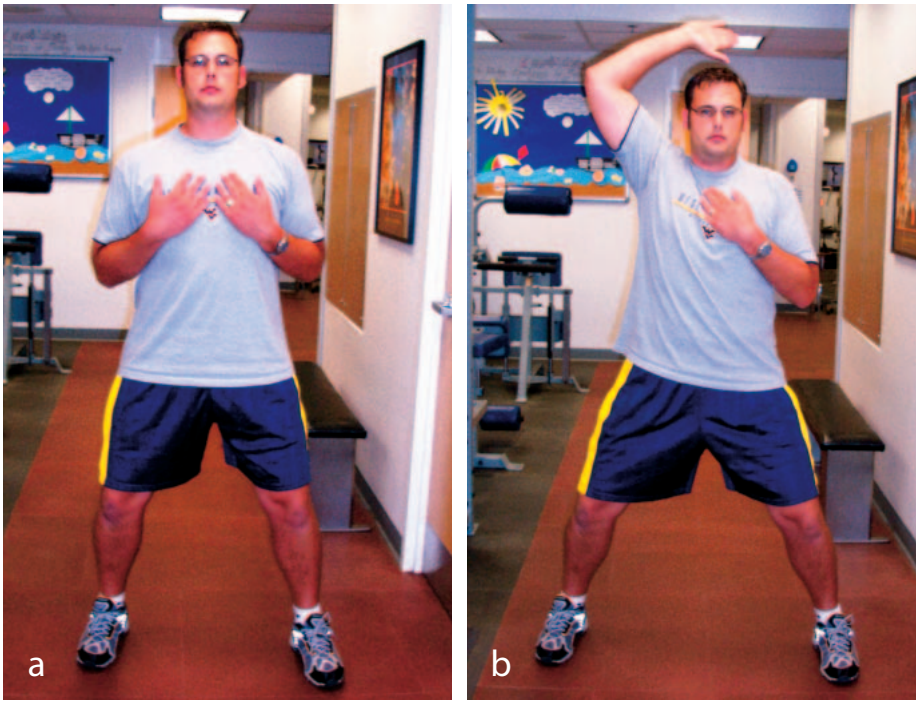

Figure 17. Lateral lunge: (a) starting position; (b) retraction/upward rotation.

Figure 18. Forward lunge: (a) protraction; (b) retraction.

Figure 19. "Lawn mower" pull: (a) protraction/depression; (b) retraction/elevation.

"Six Pack" Exercises (Table 4)

Position 1 (Figure 21a)

To Strengthen Scapular Retractors and Posterior Rotator Cuff Muscles. Lying on your stomach, move your arms so they are directly to the side of the shoulders (approximately 90° abduction) with the elbows straight and the hands pointing to the floor. Move the scapulae into retraction and the shoulder into horizontal abduction. Hold for 6 seconds.

Position 2 (Figure 21b)

To Strengthen Scapular Retractors and Posterior Rotator Cuff Muscles. Lying on your stomach with your arms in the same position as position 1, turn your thumbs up to point to the ceiling. Perform the same movement as in position 1, and hold for 6 seconds.

Position 3 (Figure 21c)

To Strengthen Scapular Retractors/Elevators and Posterior Rotator Cuff Muscles. Lying on your stomach as in position 1, move your hands and shoulders so the hands are in line with your eyes (approximately 110° of abduction) with the elbows straight and the hands pointing to the floor. Move the scapulae into retraction and slight elevation and the shoulder into horizontal abduction, and hold for 6 seconds.

Position 4 (Figure 21d)

To Strengthen Scapular Retractors/Elevators and Posterior Rotator Cuff Muscles. Starting in position 3, turn your hands so the thumbs point to the ceiling, and hold for 6 seconds.

Position 5 (Figure 21e)

To Strengthen Scapular Retractors/Depressors and Posterior Rotator Cuff Muscles. Lying on your stomach, bend your elbows to 90°, turn your palms so your thumbs point up, and move

Figure 20. "4-Count" exercise: (a) position 1; (b) position 2; (c) position 3; (d) position 4.

Table 4
"Six-Pack" Exercises

Exercise	Targeted Muscles	Safety Considerations
Position 1 (Figure 21a)	Rhomboids, upper-, and mid trapezius, supraspinatus, and teres minor	Safety considerations are the same for all 6 positions. Exercises should be performed on an athletic training table if possible. The amount of movement will be based on shoulder and upper back flexibility. If movement is painful, omit exercise.
Position 2 (Figure 21b)	Rhomboids, upper-, and mid trapezius, supraspinatus, and teres minor	
Position 3 (Figure 21c)	Rhomboids, upper- and mid trapezius, levator scapula, supraspinatus, and teres minor	
Position 4 (Figure 21d)	Rhomboids, upper- and mid trapezius, levator scapula, supraspinatus, and teres minor	
Position 5 (Figure 21e)	Rhomboids, upper-, mid- and lower trapezius, pectoralis minor, lower serratus anterior, supraspinatus, and teres minor	
Position 6 (Figure 21f)	Rhomboids, upper-, mid- and lower trapezius, pectoralis minor, lower serratus anterior, supraspinatus, and teres minor	

your arms to the same level as the shoulder (approximately 90°). Retract your scapulae and raise your thumbs to the ceiling (externally rotating your shoulders). Hold for 6 seconds.

Position 6 (Figure 21f)

To Strengthen Scapular Retractors/Depressors, Posterior Rotator Cuff, and Latissimus Dorsi and Teres Major Muscles. Lying on your stomach, place palms on the table beside your hips, keeping your elbows straight. Raise your hands as high as you can and retract your scapulae. Hold for 6 seconds.

Manipulation of the Training Variables

- *Frequency.* 1–2 days per week (the exercises should be done before practice on nonpitching days).
- *Intensity (Repetitions per Set).* Perform all 6 positions in succession, 1–2 sets.
- *Progression (Volume and Frequency).* Begin with 1 set of each exercise, and progress to 2 sets, 2 days a week.

Conclusion/Discussion

The overhand throw places considerable and varied load upon the shoulder complex. The rapid transition between eccentric (i.e., cocking phase) and concentric (i.e., acceleration phase) muscle actions during the baseball pitch produces tremendous forces on and around the glenohumeral joint, contributing greatly to soft tissue microtrauma of the shoulder complex. The intention of this article was to inform the reader of the various stresses involved in the baseball pitch, as well as some of the injuries associated with such activity. Additionally, we provided a systematic and comprehensive shoulder training routine focusing on the entire shoulder complex, something that, in our opinion, has been missing from the repertoire of general strength training programs intended for pitchers. Based upon our experience, exercise training for baseball has not been as individualized or position-specific as needed; some training programs for pitchers overemphasize strengthening the rotator cuff muscles, neglecting the fixators of the scapula. Additionally, if activity analysis is not utilized, those professionals responsible for implementing strength and conditioning programs may simply prescribe exercises intended for the general population (2). Training the baseball pitcher is unique, and exercise prescription for this type of athlete should accommodate specific pitching kinematics. It is our belief that facilitating a sport-specific training program for the baseball pitcher may improve performance and reduce the incidence of injury to the shoulder complex. ♦

Figure 21. "Six pack": (a) position 1; (b) position 2; (c) position 3; (d) position 4; (e) position 5; (f) position 6.

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Jeran

Jeffrey Jeran is Wellness Program Director for the Morgantown Branch of the National Institute of Occupational Safety and Health and Centers for Disease Control and Prevention.

Chetlin

Robert Chetlin is an Assistant Professor in the Division of Occupational Therapy at the West Virginia University School of Medicine.

Correction for Training the Shoulder Complex in Baseball Pitchers: A Sport-Specific Approach

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