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A Comprehensive Approach to Shoulder-Complex Maintenance

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THE SHOULDER HAS AN EXtremely large range of motion primarily due to the lack of bony congruency and the very shallow cavity of the glenoid, which holds the ball of the humerus. Although 4 articulations are present in the shoulder complex, this article will specifically focus on the glenohumeral joint, the most mobile joint in the human body and the site of the majority of shoulder injuries (4). Because of this shallow socket and limited support, the connective and muscle tissues must be prepared to provide the needed stabilization, especially in many of the extreme movements found in athletics. However, the main supporting musculature, consisting of the rotator cuff (subscapularis, infraspinatus, teres minor, and supraspinatus) and the scapular stabilizers (serratus anterior, rhomboids, trapezius, and levator scapulae) are often neglected in daily training regimens. Although each of these muscles has its own individual actions, their main role is to stabilize the humeral head in the glenoid by controlling the rotation of the shoulder. In weight training and athletics, the repetitive movements and daily stresses of training force these groups of muscles to exert an even greater force to stabilize the humeral head. This excessive stimulation from activity can begin a negative cycle that is very common among athletes, especially weight trainers (6). The cycle usually starts with shoulder pain and the avoidance of certain movements, which causes atrophy of the involved musculature and eventually results in instability and possible impingement. Imbalances of strength and coordination occur from this continuous training and are only reinforced as the athlete continues to perform these exercises. These imbalances are often the root of many training injuries and may predispose athletes to a greater risk of injury during training and competition.

These shoulder injuries may be prevented by performing exercises that are included as part of the core of the workout rather than as a solution to pain or injury. Dan Pfaff, trainer of several track and field Olympians, was quoted as saying, "There is a fine line between physiotherapy and the training of the elite athlete." A knowledge of shoulder biomechanics and the rigors of sport should be sufficient to implement a program to maintain a healthy shoulder, despite the daily demands placed on the joint. Even among completely healthy athletes, shoulder musculature function has a diminished ability to receive information and provide stability (1). The specifics of certain movements to avoid and of rehabilitation exercises are not in the scope of this article, for the aim is to allow healthy athletes to completely pursue their sport and training goals without any limitations. Injury prevention and proper maintenance of the shoulder complex will be addressed through 3 areas that focus specifically on proprioception, strength, and endurance for the rotator cuff and scapular musculature. Although some exercises may often seem to overlap 1 or more of the other areas, each exercise predominantly represents 1 of the 3 categories. Specific attention to the 2 external rotators of the rotator cuff, the teres minor and infraspinatus, will be given because

Figure 1. One-arm stabilizing exercise using a stability ball.

Figure 3. Strengthening the trapezius and rhomboids.

Figure 2. Dribbling a ball against a wall with the arm abducted.

Figure 4. Strengthening the infraspinatus and teres minor.

electromyographic work has identified them to be the primary shoulder stabilizers in abduction and overhead motions (3).

■ Proprioception

Proprioception, the sense of joint position, provides feedback to maintain stability during both static and dynamic activities. In a study evaluating shoulder function, athletes with unstable shoulders had a significantly decreased proprioceptive ability. The capsule and ligaments contribute to stability by providing an afferent feedback for reflexive muscular contraction of the rotator cuff (9). Damage to these ligaments causes less proprioceptive afferent information, failing to protect the shoulder from extreme movements (2). There has been little conclusive research on set repetition and duration for kinesthetic exercises; however, shorter set duration ensures quality execution, the goal of proprioception. Performing these movements first in the shoulder program and providing full rest between sets are also recommended to allow complete focus on posture and performance. If coaches or athletes have little time to perform such exercises, longer set durations may be used to simultaneously improve muscle endurance.

Examples of closed chain exercises include push-ups on a round ball (stability or medicine ball) or 1-arm stabilizing exercis-

Table 1
Proprioceptive Guidelines

Aspect	Exercise Examples		
Static	One arm stabilization or push-ups on raised surface, ball, wobble board. Walk outs on hands while trunk is supported by ball or stool.		
Dynamic	Wall/trampoline bounce with basketball, tennis ball, medicine ball.		
	Sets	Set duration	Rest period
	2–4	<30 sec	Full

Note: Exercises eventually should be performed with eyes closed.

Table 2
Strength Guidelines

Contraction type	Exercise examples		
Auxotonic	Rows (seated, bent over, dumbell), shrugs, weighted push-ups.		
	Sets	Repetitions	Rest period
	3–5	3–8	≤120 sec
Isometric	Prone abduction at 90 or 110 degrees (palms down or thumbs up), empty can, external rotation (thumbs up), rows, shrugs, supine protraction.		
	Sets	Repetitions/duration	Rest period
	2–4	3–5/5–6 sec	60 sec

Note: According to Hartmann and Tunnemann, "auxotonic literally means 'increased tension,' although here it is used in the sense of 'variable tension.' The constant addition or subtraction of motor units recruited causes the muscle to adapt to constantly changing tension requirements" (5).

es on a ball or wobble board (Figure 1). These positions teach the athlete to maintain static positions in unstable situations. Exercises such as dribbling a basketball or medicine ball against the wall with the arm abducted will target the other aspect of kinesthesia, dynamic proprioception (Figure 2). As these movements become easier, the athlete may close his or her eyes to eliminate the visual cues and make the exercises more challenging. Both static and dynamic aspects should be included in a training program, ideally alternating the 2 methods every workout or training week. These types of exercises listed in Table 1 can encourage proper stabilization of the scapula and be effective later in the rehabilitation after an injury such as a rotator cuff tear.

Strength

If an athlete plans to compete in explosive activities or against larger loads, he or she must perform some training against heavy resistance. Preparing the rotator cuff muscles and scapular stabilizers to bear heavy loads can be achieved first through some familiar core exercises. Shoulder shrugs and rowing (seated rows, bent-over rows, etc.) target the major scapular stabilizers, trapezius, levator scapulae, and rhomboids. Shrugs and rows should be performed without modifications or restrictions to allow the athlete to use these larger muscles to move heavier weights. Many combinations of sets, repetitions, and rest intervals may be used to target the general strength of these muscles. Because of the higher fast-twitch fiber composition and larger size of these muscles, 8 repetitions or fewer are recommended for maximal strength gains; however, 5 repetitions or fewer will minimize hypertrophy if gaining size is a concern (8). To gain full recovery and optimize force out-

Figure 5. Training the rotator cuff muscles by external rotation with the arm abducted to 90 degrees.

Figure 6. Standing arm abduction with rubber tubing.

put, rest periods of at least 2 minutes are recommended.

Although most sports involve dynamic actions, stability must be present throughout the movement. Therefore, isometric contractions are also an integral part of the strength category because an athlete may continue to train the stabilizers without any joint movement. However, this strength development is angle specific and must be trained in various positions. Guidelines for isometric exercises include 3–5 repetitions in each position, 5–6 seconds in duration, with rest periods of 60 seconds (10). The goal of this program prepares the healthy athlete for intense activity; therefore, the force exerted should be maximal. Weights may be held during the repetitions to accommodate this higher intensity and lower repetitions. For maintenance of strength, each isometric position should be performed twice a week.

The best positions to strengthen 2 of the scapular retractors, the trapezius and rhomboids, place the athlete in the prone position with the arms held at specific positions for the required time. Ideally, the arms are held parallel with the floor at approximately 90 or 110 degrees arm abduction with the palms facing down (Figure 3). By pointing the thumbs up during the same exercise, the supraspinatus may be strengthened. To target the infraspinatus and teres minor, the prone athlete abducts the arms to 90 degrees and holds the hands at the extreme end of his or her external rotation (Figure 4). The variety of exercises that may be used for this category are endless and may be catered to the athlete and his or her weakness. Table 2 lists some of these general positions that have been successful in the prevention of shoulder injuries.

Endurance

Although the majority of movements in the weight room and athletic realm involve short bursts of medium to high intensity, endurance is required to both resist the onset of fatigue and aid in the recovery between bouts. Shoulder instability often occurs when these rotator cuff and scapular muscles become fatigued. The high-volume work associated with endurance is also the best method for improving tendon and ligament strength (7). The strength of these supporting structures is crucial because as a muscle contracts, the tendons tighten the shoulder capsule along with the ligaments that connect the bones of the joint. This tension in the capsule holds the humeral head in the socket, providing the required stability. Hartmann and Tunnemann (5) describe an intensive interval method that improves endurance specifically for training involving medium to high intensity. Usually 3–6 sets lasting from 20 to 45 seconds (with a 30-second duration being optimal) are performed at 50–60% repetition maximum, attempting to complete as many repetitions as possible. Rest periods last between 60 and 90 seconds.

Because of the rotator cuff muscles' role in stability, these muscles should also be trained at higher repetitions to avoid fatigue in future bouts (8). External rotation can be performed either with the elbow at the side or with the arm abducted to 90 degrees (Figure 5). The elbow position dictates the involvement of the external rotators. To target the

infraspinatus more effectively, the athlete should have greater arm abduction, abducted to 90 degrees. The teres minor is more active when the exercise is performed with the elbow at the side. An exercise involving elastic tubing, standing arm abduction, begins with the arms at various heights (below waist, shoulder height, above waist) and has the athlete pull both hands away from his or her midline with straight arms (Figure 6). The supraspinatus may be strengthened through the "empty can" exercise, involving elevation of a dumbbell to just below shoulder level with internal rotation of the shoulders. The elbow is kept straight with the thumb pointing down, while the arm is raised at a 30-degree angle to the body (Figure 7).

These high repetition sets are also recommended for the larger scapular stabilizers to delay the onset of fatigue during activity. Therefore, the traditional exercises previously mentioned, such as rows and shrugs, may be performed for the allotted time period. For injured athletes or rehabilitation programs, slower tempos are advised. However, the goal of this program is to prepare healthy athletes for the nature of intense activity, and these high-speed exercises found in Table 3 are more sports specific.

Figure 7. **Strengthening the supraspinatus with the "empty can" exercise.**

Application

As indicated, these guidelines are intended for the relatively healthy athlete, used as preventive measures and not for rehabilitation

Table 3
Muscle-Endurance Guidelines

Muscle group	Exercise examples		
Rotator cuff	External rotation (elbow at side, arm abducted at 90 degrees), empty can, standing arm abduction at various heights.		
Scapular stabilizers	Rows, pushups with scapular protraction, shrugs, seated press-ups.		
	Sets	Repetitions/Set duration	Rest period
	3–6	As many as possible/20–45 sec	60–90 sec

Table 4
Two-Day Shoulder Maintenance Program

Aspect	Day 1	Day 2
Proprioception	Wall Dribble 3 × 20 sec (6-lb med ball)	One-arm stabilization on ball 4 × 15 sec
Strength	Prone abduction (90 degrees) 3 × 4 (10-lb plate)	Bent-over rows 4 × 5
Endurance	External rotation (90 degree abduction) 3 × 30 sec (tubing)	Empty can 4 × 30 sec

purposes. Unfortunately, it often takes an athlete and staff several injuries and consequences to decide to initiate a maintenance program. The incorporation of these movements into a training routine can be limitless. Variety is crucial to constantly challenge the athlete, target different muscles, and avoid staleness. However, each of the 3 areas must be addressed in every workout to ensure proper preparation, though in many cases the number of repetitions or set duration may be adjusted to include another aspect, such as muscle endurance. Depending on an athlete's training cycle, shoulder maintenance can be done within a session, while resting or waiting a turn in practice, or as a detailed workout that specifically focuses on an athlete's weaknesses. During resistance workouts, the 3 exercise categories are best used in a cooldown to avoid tiring the muscles before the training session. Table 4 shows an example of a simple 2-day program to maintain healthy shoulders. These workouts can also be designed for off days, travel days, or active rest days as a means of recovery. The most important concept is to prevent and maintain this unique joint before the problem becomes an issue we cannot resolve. ▲

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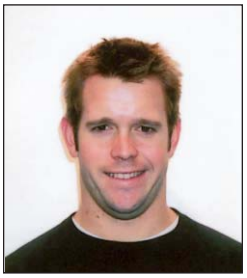

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