Overhead athletes including those in racket sports, throwers, volleyball players, and swimmers require full, unrestricted use of their upper extremities to compete at optimal levels. Scapulothoracic and scapulohumeral (rotator-cuff) muscle function are critical for normal overhead activities of the shoulder and play an important role in normal shoulder function. Furthermore, weakness of scapulothoracic and scapulohumeral muscles is a common cause of shoulder pathology. The primary purpose of this article is to describe therapeutic exercises that activate the scapulothoracic and scapulohumeral muscles. They were derived from literature examining the electromyographic (EMG) activation of the scapular muscles. Therapeutic exercises have been investigated using surface and indwelling EMG electrodes in order to determine to what level specific scapulothoracic and scapulohumeral muscles are activated. Electromyographic studies will be cited to provide a rationale for exercise recommendations to strengthen scapulothoracic and scapulohumeral muscles.

Key Points

- Scapular-muscle function is critical for full unrestricted activity in overhead athletes.
- Scapular function requires control of both the scapulothoracic and scapulohumeral muscle groups.
- There is sufficient EMG evidence regarding favorable exercise techniques to elicit high muscle-firing patterns for both the scapulothoracic and scapulohumeral muscle groups.
- Key Words: muscle strength, muscle endurance, scapulohumeral

Scapulothoracic Muscles and Pathology

Because of the overt mobility present at the human glenohumeral joint, overhead athletes require a stable base of operation at the scapulothoracic joint. To maintain stability, the scapula relies very heavily on the muscles of the scapulothoracic region. If scapulothoracic muscles are not functioning properly because of aberrant motion or asynchrony of the firing patterns, overhead athletes are at great risk for injuries such as subacromial impingement and other overuse syndromes.

Moseley et al. assessed scapular-muscle activity with indwelling EMG electrodes. In their study, an exercise was considered a significant challenge if it generated at least 50% of the muscle’s maximum contraction. The researchers focused on the scapulothoracic muscles: the serratus anterior, the trapezius, the rhomboid muscles, and the pectoralis minor. Four scapular-muscle exercises were determined to generate the most activity in healthy subjects. These exercises included scaption (scapular-plane elevation; Figure 1), rowing (Figure 2), push-up with a plus (Figure 3), and press-up exercises (Figure 4). These exercises are commonly known as the Moseley scapular core exercises. These and others are used in a thorough program to address scapulothoracic-muscle impairments.
The outer superior borders of first 7–10 ribs and the intercostal muscles are the point of origin for the serratus anterior muscle, and the lower medial scapula border is the insertion. The serratus anterior forms an important force couple with the trapezius muscles that produces upward rotation of the scapula—a motion critical for overhead movements. Decker et al.\textsuperscript{2} demonstrated that several exercises sufficiently activated the serratus anterior; these included the forward punch (Figure 5), scaption (Figure 1), dynamic hug (Figure 6), and push-ups plus (Figure 3). Ekstrom et al.\textsuperscript{3} agreed that the push-up plus was a very high-level serratus exercise. They also found that the combined glenohumeral motions of flexion, horizontal adduction, and external rotation (Figure 7), as well as glenohumeral abduction to 125\degree in the plane of the scapula (Figure 8) and glenohumeral flexion to 125\degree with protraction, elicited high levels of EMG activity.

Trapezius Muscles

The trapezius is a very broad triangular muscle originating from the occiput to the lower thoracic spine. It inserts on the clavicle, the acromion, and the spine of the scapula. The upper and lower trapezius and the serratus anterior are thought to be the primary upward scapular rotators during overhead motions.\textsuperscript{4} Ekstrom et al.\textsuperscript{5} evaluated trapezius EMG activity and found that the unilateral shoulder-shrug exercise produced the greatest EMG activity in the upper trapezius, whereas shoulder horizontal abduction with external rotation and the prone overhead arm raise in line with the fibers of the lower trapezius muscle activated the middle trapezius to the fullest extent (Figure 9).

Rhomboid Muscles

The rhomboid muscles lie on the posterior thorax, originate on the thoracic spine, and insert to the medial scapular border. The rhomboid muscles pro-