Scapular and Shoulder Girdle Muscular Anatomy: Its Role in Periscapular Tendon Transfers

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Continuing Medical Education

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Editors

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Learning Objectives

Upon completion of this CME activity, the learner should achieve an understanding of:

- The anatomy of the muscles that act on the scapulothoracic articulation and their innervation.
- The biomechanics and pathophysiology of scapulothoracic motion and dysfunction.
- Muscle transfers available for a variety of paralytic conditions of the shoulder girdle.

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The importance of coordinated, normal scapulothoracic motion in facilitating full, pain-free motion of the shoulder complex has been increasingly studied over the past decade, leading to renewed interest in scapular-based reconstructions to improve shoulder girdle motion through the use of muscle advancements and tendon transfers. This article will review recent advances regarding scapulothoracic motion and the muscular stabilizers of the scapula, focusing on clinical diagnosis and anatomy as it pertains to scapular dyskinesis and common periscapular tendon transfers. Although many of these treatment techniques remain in their infancy and further follow-up is necessary before universal adoption, they provide a novel

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means of addressing difficult-to-treat and complex shoulder girdle pathologies. *(J Hand Surg Am. 2016;41(2):306–314.*

Key words Scapula, scapular musculature, trapezius, serratus, rhomboids.

Despite the scapula's role as the platform for upper extremity motion, the scapula, scapulothoracic mechanics, and periscapular musculature are often overlooked in the routine workup of both the painful and the dysfunctional shoulder. The scapula is overlooked for multiple reasons including a limited understanding of the complex muscular stabilization and motion of the scapula as well as the relatively rare indications for scapular surgery historically. Over the past 1 to 2 decades, increased attention has been paid to the scapulothoracic articulation from a research and clinical standpoint. This has led to a better understanding of the scapula's role in normal upper extremity motion and has demonstrated that altered scapulothoracic motion can be found in 68% to 100% of patients with shoulder injuries.[1] Novel treatment options for complex problems ranging from brachial plexus injuries to pseudoparalysis related to massive irreparable rotator cuff tears are being undertaken as a result.

This review will primarily focus on the relevant surgical anatomy and function of the periscapular musculature in normal scapular motion as well as physical examination findings in the most common forms of scapular dyskinesis. This information should help surgeons to perform the most common periscapular tendon transfers, especially because these techniques and their indications continue to grow and be optimized. As with forearm tendon transfers, it is important to remember the 5 basic tenets of tendon transfer: (1) similar line of pull, (2) similar tension, (3) similar excursion, (4) one transfer for one lost function, and (5) normal or near normal strength of the donor muscle.

SCAPULAR MECHANICS

The scapula is unique because, with the exception of its connection to the clavicle, it is a floating bone nearly completely stabilized by muscles. It must not only support the large loads generated by the long lever arm of the upper extremity but also position the glenohumeral joint and arm in space for tasks ranging from heavy lifting and pitching to microsurgery. The shoulder complex is predominantly made up of 14 muscles; of these, 8 cross the glenohumeral joint. The remaining 6 muscles stabilize the scapulothoracic articulation. These include the trapezius, serratus anterior, levator scapulae, rhomboid major and minor, and pectoralis minor muscles.

Recent studies have defined a widely accepted reference frame and terminology for scapulothoracic motion. Scapular motion is defined by translation across the chest wall in 2 planes and rotations of the scapula about 3 planes. Translation is defined by mediolateral and superior-inferior motion of the scapula along the chest wall. Rotationally, the scapula has 3 degrees of freedom that include (1) upward or downward rotation in the coronal plane of the scapula (clockwise or counterclockwise rotation of the scapula when viewed from behind); (2) internal or external rotation, which describes axial plane rotation about the medial scapular border (motions moving the glenoid anterior or posterior compared with the medial scapular border); and (3) rotation in the sagittal plane of the scapula as defined by an axis along the scapular spine (anterior or posterior tilt of the superior segment).[2] Ludewig et al[3] used surgically placed pins in the clavicle, scapula, and humerus to define the resting position of the bones and their position in forward flexion, elevation in the scapular plane (scaption), and abduction in the plane of the body. They found the scapula at rest to be internally rotated 40° to the plane of the body, rotated upward 5°, and anteriorly tilted 14°. Elevation, scaption, and abduction led to great increases in upward rotation and posterior tilt. Biomechanically, these complex motions are critical to allow the acromion to clear the humerus without impingement. This was demonstrated in a cadaveric study by Mihata et al,[4] which showed that in a throwing model of late cocking, there was increased internal impingement when the scapula was positioned with less upward rotation or more internal rotation. Studies defining normal scapular kinematics and demonstrating the relationship between decreased scapular motion and impingement have been reproduced using multiple methodologies.[5–10] Scapular functional motions such as retraction, protraction, and shrug entail combinations of translation and rotation (Fig. 1). Scapular retraction, as seen with arm elevation or abduction, combines medial scapular translation with upward and external rotation and