8 Evaluation of the Stability and Function of the Scapulothoracic Joint

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8.1 Biomechanics

The scapula is fixed anteriorly to the thoracic cage through the acromioclavicular (AC) joint, the clavicle, and the sternoclavicular (SC) joint. Additionally, its posterior connection to the ribcage is ensured by the trapezius, rhomboids, and serratus anterior muscles [1].

Simplified, the biomechanical properties of the scapula are comparable to those of a triangle (Fig. 8.1) consisting of a stable medial side (thoracic platform) and two mobile sides anterior (clavicular boom) and posterior (scapular body and peri-scapular muscles). The scapula's position is defined by the degree of elevation in the SC joint, length of the clavicle, and tension of the peri-scapular muscles. Thus, the anterior stabilizers are hinged, however, are noted to be static; they elevate the scapula and maintain its lateral position and create the anterior part of the aforementioned triangle. The scapula and the posterior dynamic stabilizers (or peri-scapular muscles) combine into the posterior side and mobilize the scapula along the "scapular track". These two sides are stabilized by the medial side—the thorax. This interaction allows the scapula to accurately position the rotator cuff to move the humeral head and orient the glenoid anterolaterally, thus enabling a functional plane of the shoulder [2].

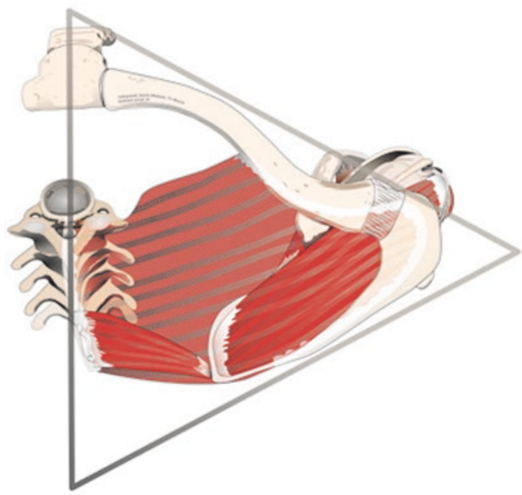

Fig. 8.1 Displaying the scapula's triangle-like build. The triangle's stable medial side is created by the thorax. The length of the clavicle defines the static anterior side of the triangle. The posterior side however, comprising the scapular body and peri-scapular muscles, moves the scapular dynamically along its "scapular track". Picture adapted from [2]

In general, physiological movement of the scapula is achieved by combining three components of motion:

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1. upward/downward rotation around a horizontal axis perpendicular to the plane of the scapula
2. internal/external rotation around a vertical axis along the medial border of the scapula
3. anterior/posterior tilt around a horizontal axis along the scapular spine.

Of importance, the clavicle as its connection to the axial skeleton enables two translations:

1. upward/downward rotation (also known as a shrug)
2. retraction/protraction around the rounded thorax [3–5]

Elevation of the humerus is achieved by clavicular elevation, retraction, and posterior axial rotation at the sternoclavicular joint, while the acromioclavicular joint allows for scapular internal and upward rotation as well as posterior tilting [6].

Proper shoulder girdle function requires a complex and coordinated force development and force regulation, which is achieved by the surrounding muscles as well as ligamentous tension of the AC and SC joint [7, 8].

As such, the synergistic humeral and scapular movements are essential to ensure a coordinated scapulohumeral rhythm [9]. Further, during active glenohumeral abduction, the ratio of humeral and scapular movement is 2:1. Of interest, the 2:1 ratio between glenohumeral abduction and scapular rotation may often be observed in the throwing athlete with any disruption resulting in functional impairment [10]. Thus, during the first 30–50° of shoulder abduction, the scapula moves laterally. With increasing active abduction, the scapula rotates approximately 65° (in an arc) until full active shoulder abduction is achieved [10, 11].

The aforementioned, complex interactions between the glenohumeral and scapulothoracic joints highlight that appropriate and correct assessment of the scapulothoracic joint is an important part of the clinical examination. Thus, it seems evident that any intra- or extra-articular shoulder disorders, including rotator cuff tears as well as glenohumeral or acromioclavicular instability, may cause an abnormal scapulothoracic rhythm, often requiring subsequent treatment [12–14].

These abnormal scapular positions (asymmetry or increased topography) and motions have been collectively termed "scapular dyskinesis" [13]. Extensive research has been done on the causative factors for scapular dyskinesis utilizing Moire topography analysis [15], skin electrode monitors [16, 17], and bone pins [18].

8.2 Clinical Examination

One of the most important and common classifications of scapular dyskinesis has been described by Kibler et al. [19] in 2003. Kibler and colleagues classified scapular dyskinesis into three different types (in patients in a resting standing position):

– Type I: prominence of the inferior medial scapular border
– Type II: prominence of the entire medial scapular border
– Type III: superior translation of the entire scapula and prominence of the superior medial border of the scapular

During clinical examination the scapulothoracic rhythm is best assessed from posterior by observing the scapula, while the patient actively raises and lowers the arm.

As such, by carefully observing the descending movement of the arm, any muscle weakness and slight scapular dyskinesis can be observed [10]. Patients may also be asked to retract, protract, and shrug the shoulder so that any—even slight—asymmetry becomes evident.

A common pathology encountered by shoulder surgeons is injury to the AC joint, in which scapular dyskinesis may already be evident 10 days after the trauma, when initial symptoms have subsided [14]. In this setting, scapular dyskinesis develops due to the clavicle's inhibited function regarding the physiological motion of the clavicle as an anterior strut through the AC and coracoclavicular (CC) ligaments [6, 20, 21]. Scapular dyskinesis may develop in (type II) AC joint injuries due to disruption of the AC ligaments and concomitant loss of the clavicular strut. In addition, disruption of the AC and CC ligaments in AC joint injuries (type III or higher) may also cause scapular dyskinesis [4]. The extent to which scapular dyskinesis persists influences the need for surgical intervention in patients presenting with AC joint injury, consequently being a substantial part in recently proposed treatment algorithms [4, 14].

In particular, patients with acute or chronic AC-joint injuries present with scapular dyskinesis that is caused by a protracted and internally rotated scapula. This may result in intractable glenohumeral and lateral shoulder pain as well as limitations in functional range of motion. Chronic functional deficits and persistent pain, observed by any concomitant scapular dyskinesis, may indicate the need for surgical intervention [4, 14].

8.2.1 Scapular Assistance Test

During the scapular assistance test, the examiner pushes upward and laterally on the inferior medial border of the scapula, while active shoulder abduction is performed (Fig. 8.2). As such, the examiner simulates the force of the serratus anterior muscle in the elevation force couple. The test is deemed positive if pain relief is observed [10].

Fig. 8.2 Scapular assistance test

8.2.2 Scapular Retraction Test

A highly valuable tool for detecting full-thickness rotator cuff tears is by following the more traditional Jobe test up with the scapular retraction test [22]. For Jobe test, (Fig. 8.3): the patient is asked to perform internal shoulder rotation, flexion to 90°, and abduction that is collinear to the scapular axis, with then trying to resist downward pressure applied by the examiner. Subsequently, the test is repeated with additional manual stabilization of the patient's medial scapular border by retracting the scapula with the volar aspect of the hand and placing the forearm against it for support (Fig. 8.4) [23].

Fig. 8.3 Jobe test

Fig. 8.4 Scapular retraction test

If the stabilization of the scapula leads to a restoration of strength, meaning the patient resisted the examiner's downward pressure during the Jobe test, the scapular retraction test is positive. A positive scapular retraction test indicates an intact rotator cuff.

In contrast, continued weakness or arm dropping is defined as a negative scapular retraction test, indicating a full-thickness rotator cuff tear [23].

8.2.3 Lateral Scapular Slide Test

First proposed by Kibler et al. in 1998, the lateral scapular slide test may be best used during clinical follow-ups, in order to quantify the degree of scapular dyskinesis. The lateral scapular slide test usually evaluates the exact position of the scapula on both the affected and non-affected side. Thus, the distance of the inferomedial border of the scapula to the spine can be measured with both arms hanging on the side; both arms resting on the hips, and with both arms in 90° abduction and maximal glenohumeral internal rotation (Fig. 8.5). Differences of more than 1.5 cm in any position between the affected and non-affected side are considered pathological [10].

Another modality to quantify the degree of scapular dyskinesis has been proposed by Park et al.. The authors reported that a 3-dimensional wing computer tomographic analysis can be an efficient tool with a good interrater reliability for evaluating scapular dyskinesis with a significant correlation to the physical exam [24].

Fig. 8.5 Lateral scapular slide test

8.2.4 Scapular Winging

Various pathologies of the upper extremity have been identified in current literature as causes for scapular winging, with thoracic longus nerve palsy, resulting in concomitant serratus anterior impairment, being the most common one.

The evaluation starts with the arm in the resting position. In patients with thoracic longus nerve palsy, a medialized scapula in the resting position is characteristic. Due to the lack of activating the serratus anterior muscle, patients may have difficulty with shoulder abduction above 120°; concurrently, the degree of winging increases as well [25].

The patient may also be asked to actively perform shoulder flexion. During this manoeuvre, any scapular movement in relation to the thoracic wall can be observed. As such, winging may be present with resisted motion (e.g. when performing wall push-ups) (Fig. 8.6). Thus, scapular winging may occur in static, dynamic, or resisted motions [25].

Furthermore, other pathologies—for example, accessory nerve palsy—have also been identified to be a risk for causing what is referred to as "pseudowinging" [26]. Patients with "pseudowinging" due to accessory nerve palsy—and a concomitant trapezius muscle impairment—present with a depressed shoulder, laterally translated scapula, and a laterally rotated inferior angle. Trapezius wasting, inability to shrug the shoulder, and difficulty to actively perform shoulder flexion and abduction may confirm the diagnosis [25].

In patients with scapular winging, a thorough examination of the adjacent structures including the glenohumeral joint, acromioclavicular joint, and cervical spine should be performed to differentiate scapular winging or "pseudowinging" from other pathologies.

Fig. 8.6 Wall push-up

8.3 Summary

The scapulothoracic joint is stabilized medially by the thorax and both stabilized and statically moved anteriorly by the clavicle and manoeuvred on the so-called scapular track by the peri-scapular muscles. Together, these structures that influence the position of the scapula also enable the shoulder joint to perform physiologically.

Any form of unphysiological scapula setting or movement, collectively termed scapular dyskinesis, may be caused by various shoulder pathologies, such as rotator cuff tears, shoulder instability, and injuries to the AC joint.

Thoroughly observing the movement of the scapula by applying the aforementioned clinical tests may help the examiner to differentiate between the pathologies that cause an unphysiological position or movement of the scapula and guide their treatment.

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