Many athletic therapists appreciate the role that scapular function plays in maintaining the integrity of the shoulder and therefore include its assessment in their comprehensive shoulder evaluation. A clinician’s observation might result in a determination of pathology called scapular dyskinesis, indicating the presence of abnormal scapular motion or position. This term is used to describe a lack of neuromuscular control or ineffective positioning of the scapula but does not describe the abnormal motion observed. Reporting findings in this manner cripples communication among clinicians and hampers the further understanding of the patient’s dysfunction.

One can imagine the difficulty this creates between athletic therapists while they discuss rehabilitation protocols. Consider a clinician seeking guidance to develop a rehabilitation program for a patient with a functionally unstable ankle. The communication would suffer if the clinician’s sole description of his or her assessment were “ankle dysfunction.” The exchange would be more productive if the description included the severity and direction of instability, as well as the motion that reproduces the patient’s dysfunction. In this case a better description might have been “the athlete displays ankle instability resulting in an ankle-inversion mechanism during a figure-8 functional test.”

Our ability to effectively describe dysfunction is essential to improve communication and develop our clinical evaluation and rehabilitation skills. Because of the overlying muscle mass obscuring surface landmarks, the movement of the scapula under the skin, and the lack of lever arm to help quantify scapular movements, clinical testing of the scapula provides a greater challenge than with other joints. Several techniques have been devised to attempt to clinically evaluate scapular dyskinesis, including measurement of scapular displacement from the trunk, inclinometer, visual evaluation, and three-dimensional motion analysis. As our understanding of the role the scapula plays in normal and abnormal shoulder function evolves, so should our clinical skills.

Scapular Assessment Techniques

One of the first measurements used to assess the position of the scapula in relation to the trunk was the lateral scapular-slide test. When performing the lateral scapular-slide test, the distance from the inferior angle of each scapula is measured to a thoracic spinous process while the arms are held in three...
different positions: arms at the side, hands placed on the waist, and arms abducted to 90° and maximally internally rotated. At each position the distance from the thoracic spinous process to the inferior angle of the scapula is measured in centimeters. Kibler\(^2\) suggests that a difference of ≥1.5 cm between injured and uninjured sides indicates a scapular dysfunction that needs rehabilitation, including strengthening weak scapular retractors or stretching tight anterior shoulder muscles. This test has been evaluated by others and has demonstrated moderate reliability \((r = .5-.8)\) when one individual conducts all measurements.\(^2,3\) Odom et al.\(^3\) performed this test on a group of symptomatic shoulders and determined that the 1.5-cm difference previously suggested did not discriminate between individuals with shoulder pathology and those without it.

A measurement of posterior scapular winging using a Perry tool was found to be very reliable \((r = .92-.99)\) in both a weighted and an unweighted position with the arms at the sides.\(^4\) This method measures the amount of posterior scapular displacement in degrees relative to the plane of the posterior thoracic wall. This method, although limited because scapular orientation is measured in only one position, introduces an important concept: applying load during the assessment. It makes intuitive sense to apply an external load during assessment of the scapula and provides us with a functional test. Further research on this technique using pathological participants is warranted.

Measurement of scapular upward rotation using an electrical inclinometer placed along the scapular spine has been described. Placement of an inclinometer on the scapular spine enables objective measurement (in degrees) of scapular upward rotation during arm elevation. This technique has been reported valid and reliable \((\text{ICC} = .9)\).\(^5\) Scapular upward rotation is important to normal function, providing a rotation of the acromion up and out of the way of the proximal humerus, thus allowing full arm elevation without encroachment on the subacromial space. The technique requires some practice to maintain the inclinometer in the proper plane during arm motion, but it has been validated with three-dimensional motion analysis. This method, along with the previously described techniques, only measures scapular motion in one plane. Although these early techniques are limited, they have led to our current understanding that the scapula moves three-dimensionally and needs to be evaluated in all three planes.

Visual assessment techniques incorporating multiplanar motion have been used in an attempt to address the limitation of single-plane evaluation. Warner and colleagues used moiré topography photographs to document scapular symmetry.\(^1\) Their findings demonstrate scapular dyskinesis to be very common in patients with instability and impingement. This technique produces concentric circles of shadows over the surface of the scapulae and posterior trunk. Asymmetry was graded by the shadows around the involved scapula clustering together more than on the uninvolved side. Greater asymmetry was denoted during dynamic arm motion than in a static assessment.\(^1\) These findings illustrate the importance of assessing scapular function in a dynamic state.

More recently, Kibler et al.\(^6\) described an observational method that attempts to categorize scapular dyskinesis into one of four categories based on three potential abnormal movement planes. This assessment is made by comparing the injured and uninjured sides during dynamic arm elevation and lowering in the sagittal and scapular planes. Patients are categorized into the predominant pattern of motion as observed by the examiner. The categories are described in Table 1. It should be noted, however, that initial study revealed moderate to low reliability within and between observers.\(^6\) This system attempts to take into consideration three-dimensional and dynamic components of scapula motion during arm elevation. Its limitations are that clinicians attempt to categorize patients into one pattern when two abnormal motions might be observed. In addition, observations of bilateral dysfunctions are difficult because the system is comparison based.

The aforementioned evaluation systems are limited until a more complete understanding of normal scapular motion is appreciated. Based on a two-dimensional assessment technique of scapular and humeral motion, radiographs revealed the classic description of 2° of humeral motion for every 1° of upward scapular rotation. Recent advances in motion-analysis technology have dramatically improved our ability to evaluate scapular kinematics.
Table 1. Description of Scapular-Dyskinesis Patterns Used to Categorize Abnormal Scapular Motion

<table>
<thead>
<tr>
<th>Type</th>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Inferior-angle pattern</td>
<td>At rest, the inferior medial scapular border might be prominent dorsally. During arm motion, the predominant movement is that the inferior angle tilts dorsally and the acromion tilts ventrally over the top of the thorax. The axis of rotation for this pattern is in the horizontal plane.</td>
</tr>
<tr>
<td>II</td>
<td>Medial-border pattern</td>
<td>At rest, the entire medial border might be prominent dorsally. During arm motion, the predominant movement is that the medial scapular border tilts dorsally off the thorax. The axis of rotation is vertical in the frontal plane.</td>
</tr>
<tr>
<td>III</td>
<td>Superior-border pattern</td>
<td>At rest, the superior border of the scapula might be elevated, and the scapula can also be anteriorly displaced. During motion, the movement pattern is initiated such that the shoulder shrugs. This is in contrast to a normal pattern, in which the medial border rotates away from the midline.</td>
</tr>
<tr>
<td>IV</td>
<td>Symmetric scapulohumeral pattern</td>
<td>At rest, the positions of both scapulae are relatively symmetrical, taking into account the fact that the dominant arm might be slightly lower. During arm motion, the scapulae rotate symmetrically upward such that the inferior angles translate laterally away from the midline and the scapular medial border remains flush against the thoracic wall. The reverse occurs during lowering of the arm.</td>
</tr>
</tbody>
</table>

Scapular Three-Dimensional Kinematics

The initial step toward enhancing our ability to evaluate and rehabilitate shoulder injuries is understanding scapular motion. The unique structure and function of the scapula, however, make its motion and asymmetries challenging to identify and quantify through clinical observation. Much of the frustration clinicians feel about describing scapular-assessment findings stems from confusion about describing the motions of the scapula. Ideally, clinically testing the integrity and function of a joint is optimized given a single and easily identifiable axis of rotation and bony articulation, which is not the case with scapular motion. Assessments are facilitated given the ability to reference a normal range of motion. Because of its mobility, irregular joint surfaces, and limited bony articulation with the axial skeleton (sternoclavicular joint), clinical evaluation of the scapula proves challenging.

Three-dimensional motion-analysis technology has enabled us to measure scapular motion in multiple planes. Historically these measurement techniques proved costly, were limited only to static measurements, had questionable reliability, or required bone pins or other invasive methods. Current analyses using electromagnetic sensors taped to the sternum, scapula, and humerus are encouraging (Figure 1). Assessment of dynamic motion using electromagnetic sensors requires less invasive methods that have been validated against the gold standard of bone-pin three-dimensional motion analysis.

Figure 1 Three-dimensional analysis of scapular motion using electromagnetic sensors taped to both the scapula and the sternum (not shown).
Scapular motion can be visualized as rotation or translation of the glenoid fossa in relation to the thorax. The motions are described as upward/downward rotation and translation, internal/external rotation, and anterior/posterior tipping. Movements take place around three axes of the scapula in three planes (Figure 2 and Table 2). During humeral elevation in the scapular plane, the scapula upwardly rotates. Posterior tilting and external rotation of the scapula also take place during elevation, increasing sharply as the humerus reaches peak elevation. These actions are thought to be critical in allowing the humeral head to avoid contact with the contents of the subacromial space as elevation increases. The opposite motions are observed during the lowering phase as the scapula internally rotates, anteriorly tilts, and downwardly rotates. Given the multiplanar function of the scapula, specific descriptions of abnormal motion are beneficial. Adopting and referencing these motions will help clinicians communicate their evaluations of scapular function and pathology.

**Summary**

Assessing scapular motion is an integral part of a complete shoulder evaluation. Clinical assessment of scapular motion is most effectively done by observing from behind the patient. Adequate observation of the musculature and bony landmarks is necessary, including inferior angles, medial and superior borders, and acromioclavicular joints. Bilateral comparisons are made during multiple repetitions of arm elevation and lowering phases of forward flexion and scaption. The addition of 1- to 4-lb weights can accentuate abnormal findings. Abnormalities in both the magnitude and the quality of motion can be observed. Deficits in scapular posterior tilting (Figure 3) and external rotation (Figure 4) during arm elevation and lowering are commonly observed. Clinicians should understand that scapular motion and dysfunction can take place in one or more of the planes described.

Reporting clinical findings in commonly understood biomechanical terms would greatly enhance any clinician’s ability to effectively rehabilitate and evaluate scapular dysfunction. An example of an evaluative finding of scapular winging using

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**Table 2. Scapular Motions and Normal Ranges**

<table>
<thead>
<tr>
<th>Motion</th>
<th>Axis of Rotation</th>
<th>Plane of Motion</th>
<th>Normal Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upward/Downward rotation and translation</td>
<td>sagittal</td>
<td>frontal</td>
<td>50° ± 5°</td>
</tr>
<tr>
<td>Internal/External rotation</td>
<td>vertical</td>
<td>transverse</td>
<td>25° ± 10°</td>
</tr>
<tr>
<td>Posterior/Anterior tilting</td>
<td>horizontal</td>
<td>sagittal</td>
<td>30° ± 15°</td>
</tr>
</tbody>
</table>

*Sources: Karduna et al. and McClure et al.*

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**Figure 2** Three-dimensional motion of the scapula.
biomechanical terminology would be “standing bilateral arm elevation in the scapular plane reveals a lack of scapular external rotation of the involved shoulder during 60–90° of humeral elevation and lowering.” The clinician has effectively described the type of the dysfunction, its primary plane, and the position and motion in which it was observed.

The unique function and anatomy of the scapula have made clinical testing and measurements difficult. Despite obstacles, our understanding of scapular function and dysfunction continues to grow. New clinical testing techniques must continue to be validated, however, against the three-dimensional motion-analysis standard. An appreciation of scapular function is important when designing rehabilitation protocols with scapular motion in mind. Standard terminology is needed for effective communication among clinicians.

References


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