Qualitative clinical evaluation of scapular dysfunction: a reliability study

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The purpose of this study was to determine the intrarater and interrater reliability of a clinical evaluation system for scapular dysfunction. No commonly accepted terminology presently exists for describing the abnormal dynamic scapular movement patterns that are commonly associated with shoulder injury. A method of observation was devised for clinical evaluation of scapular dysfunction. Blinded evaluators (2 physicians and 2 physical therapists) were familiarized with the evaluation method of scapular movement patterns before viewing a videotape of 26 subjects with and without scapular dysfunction. Each evaluator was asked to categorize the predominant scapular movement pattern observed during bilateral humeral scaption and abduction motions. Reliability was assessed by a \( \kappa \) coefficient. Intertester reliability (\( \kappa = 0.4 \)) was found to be slightly lower than intratester reliability (\( \kappa = 0.5 \)). These results indicate that, with refinement, this qualitative evaluation method may allow clinicians to standardize the categorization of dynamic scapular dysfunction patterns. (J Shoulder Elbow Surg 2002;11:550-6.)

Normal shoulder motion, force development, force regulation, and ligamentous tension require coupling of scapular motion and humeral motion. Alterations in resting scapular position and dynamic scapular motion have been recognized frequently in association with many types of shoulder disorders, such as impingement, instability, and rotator cuff tears. These alterations have been considered to be abnormal motions and positions compared with the opposite side and a clinical indication of dysfunction of the scapula. They have been collectively termed scapular dyskinesis.

The term scapular dyskinesis, though indicating that an alteration exists, is a qualitative collective term that does not differentiate between types of scapular positions or motions. This hampers communication between examiners and increases the difficulty in characterizing a patient’s specific scapular involvement.

Scapular evaluation is challenging because the overlying muscle mass obscures surface landmarks, scapular movement occurs under the skin, and there is no lever arm to help quantify scapular movements. Several techniques have been devised to quantify scapular dyskinesis objectively: visual evaluation, measurement of scapular displacement from the trunk, 3-dimensional electromagnetic assessment, and Moire topography. Measurements of the scapula from the trunk only provide static assessment of scapular position at one point in space. The more dynamic techniques require equipment that is not readily available in the clinical environment. This leaves the clinician with limited tools with which to characterize dynamic scapular dyskinesis adequately. This study was designed to determine whether the observable characteristics of altered scapular motion could be delineated in a reliable manner among health care providers. The null hypothesis was that no agreement would exist between the individual observed using the evaluation system.

MATERIALS AND METHODS

Subjects

In this study, 26 subjects were evaluated (age, 29.5 ± 9 years; weight, 81.2 ± 15.95 kg; height, 178 ± 11.9 cm). Six of the subjects had no shoulder injury history and demonstrated normal shoulder range of motion. The remaining 20 subjects were being treated by the senior author (W.B.K.) and had been diagnosed by clinical examination or imaging with shoulder injuries including rotator cuff tendinitis, glenohumeral instability, or glenoid labral tear. These broad diagnostic categories were used because they are common shoulder problems and were among the diagnostic categories used in previous studies on scapular
dyskinesis. We included all 3 diagnostic categories because no specific shoulder problem seemed to be related specifically to a specific dyskinesis pattern. Subjects were excluded if they had bilateral symptoms, previous surgery, fracture in the shoulder girdle, or adhesive capsulitis. The Institutional Review Boards of both the University of Kentucky and the Lexington Clinic approved this study. All subjects read and signed informed consent before participation.

Procedure

For this study, a verbal description of clinical observations of scapular dyskinesis was developed. Clinical observation of scapular motion with arm elevation in symptomatic and asymptomatic patients by the authors, supported by biomechanical knowledge, allowed delineation of 5 categories of scapular dyskinesis. After initial pilot testing, the 4 patterns of scapular dyskinesis described in this study seemed to be representative of scapular movement patterns. After the pilot data were reviewed, it was apparent that 3 abnormal patterns represented the possible scapular movements around the thorax.12,14,15

The scapular dyskinesis clinical evaluation system is divided into 4 patterns (Table I). Type I dyskinesis is prominence of the inferior medial scapular angle, representing loss of scapular control about a horizontal axis parallel to the scapular spine (Figure 1). Type II is prominence of the entire medial scapular border, representing loss of scapular control about a vertical axis parallel to the spine (Figure 2). Type III is prominence of the superior scapular border, representing excessive upward movement of the scapula and loss of control around a sagittal axis through the scapula (Figure 3).13,14 Type IV is considered to be symmetric scapulohumeral motion, with no prominence or excessive motion relative to the uninvolved shoulder.

All subjects were videotaped from the back while standing in normal resting posture with a super-8 camera (Sharp VL-E66U; Sharp Electronics Corp, Mahwah, NJ) mounted.

**Table I** Scapular Dyskinesis System Used to Categorize Abnormal Scapular Motion

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inferior angle (type I)</td>
<td>At rest, the inferior medial scapular border may be prominent dorsally. During arm motion, the inferior angle tilts dorsally and the acromion tilts ventrally over the top of the thorax. The axis of the rotation is in the horizontal plane.</td>
</tr>
<tr>
<td>Medial border (type II)</td>
<td>At rest, the entire medial border may be prominent dorsally. During arm motion, the medial scapular border tilts dorsally off the thorax. The axis of the rotation is vertical in the frontal plane.</td>
</tr>
<tr>
<td>Superior border (type III)</td>
<td>At rest, the superior border of the scapula may be elevated and the scapula can also be anteriorly displaced. During arm motion, a shoulder shrug initiates movement without significant winging of the scapular occurring. The axis of this motion occurs in the sagittal plane.</td>
</tr>
<tr>
<td>Symmetric scapulohumeral</td>
<td>At rest, the position of both scapulae are relatively symmetrical, taking into account that the dominant arm may 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>
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Figure 1 Photograph illustrating a type I dyskinetic scapular pattern with posterior tilting of the inferior angle around a horizontal axis through the scapula.
on a tripod 204 cm away (Figure 4). The subjects were positioned with their first metatarsophalangeal joint aligned with a mark on the floor to standardize the videotaping. An adjustable backdrop (Nimlock Co, Niles, Ill) was used to provide a guide for arm elevation in the frontal plane and 45° anterior to the frontal plane (scaption). Adequate lighting was provided so that scapular motion could be delineated on the video recording. All subjects performed 3 repetitions of bilateral arm elevations in scaption and abduction in a counterbalanced order to prevent fatigue. Arm elevation and lowering were performed at a rate of 45°/s. This was controlled by having the subject practice moving through the range of motion several times while the investigator, using a stopwatch, counted each second off aloud.

Upon completion of collecting the video data, the video record of each subject was randomly recorded onto a VHS tape for review by the blinded evaluators. Each subject’s video record was preceded by a code to identify the subject during the evaluation process. Two licensed physical therapists and two physicians were selected to evaluate the videotapes. These evaluators did not work in the clinic from which the patient samples were drawn to minimize bias. The clinicians were experienced in the field of sports medicine and orthopaedics but were not familiar with the new

Figure 2 Photograph illustrating a type II dyskinetic scapular pattern with medial scapular border prominence caused by internal rotation about a vertical axis through the scapula.

Figure 3 Photograph illustrating a type III dyskinetic scapular pattern with excessive elevation of the superior border of the scapula.
patterns devised to evaluate scapular dyskinesis clinically. The 2 physicians and 2 therapists were familiarized with the definitions and method by a 10-minute visual and verbal presentation. A written description of the 4 scapular patterns was provided to each evaluator to be referred to as needed during the observation of the videotape (Table I). A video example of each abnormal pattern and a symmetric pattern was shown to the evaluators before they viewed the actual subjects. These examples were selected by the investigators to represent clear examples of the 4 patterns and were not included among the 26 subjects graded by the blinded evaluators.

Each evaluator was instructed to determine the predominant scapular movement pattern observed for each subject presented on the videotape. The randomized videotape was presented to all blinded physicians and therapists. Seventeen days after the initial observation of the videotape, 1 physician and 1 therapist reviewed the same videotape to determine intratester reliability. The videotape method of presentation was used for several reasons. First, it allowed the use of evaluators who were not associated with the senior author or with the evaluation method. Second, it allowed us to present evaluations of all subjects at one time; it would have been logistically difficult to connect the subjects with the distant observers without videotape. Third, all observers reviewed the exact same motions to minimize interday variability of fatigue, stress, and patient position.

Data analysis

Categorical data were collected for each therapist and physician. The data were analyzed with statistical software (SPSS v10.0; SPSS Inc, Chicago, Ill). A $\kappa$ coefficient is the preferred statistic for reporting the reliability of nominal or categorical data. It represents the agreement among raters beyond that expected by chance. If agreement among raters occurs simply by chance, the $\kappa$ coefficient would return a value near 0. Intertester reliability between the physicians and therapists was calculated separately. Intratester reliability was assessed for 1 therapist and 1 physician.

RESULTS

The agreement between the 2 physicians categorizing scapular dyskinesis into 1 of 4 categories was $\kappa = 0.31$ ($P < .01$), and between the 2 physical therapists, $\kappa = 0.42$ ($P < .001$). This indicates moderate agreement between the individual observers and that the categorization of the 26 subjects’ scapular movements was significantly greater than that expected by chance alone. Intratester reliability was also found to be slightly higher as would be expected for 1 physician ($\kappa = 0.59$, $P < .001$) and 1 physical therapist ($\kappa = 0.49$, $P < .001$). The null hypothesis was rejected, indicating agreement between evaluators was present. A moderate level of agreement and reliability was present with this system.

DISCUSSION

There is increasing clinical evidence that alterations in scapular resting position and dynamic motions are seen in patients with a variety of shoulder injuries. These alterations can affect shoulder performance and influence normal shoulder kinematics as a result of interference with the obligatory
closed-chain coupling of scapular motion with humeral motion.\textsuperscript{4,27} Loss of this coupling has several effects on dynamic shoulder function. Increased protraction places increased tension on anteroinferior glenohumeral ligaments and alters optimal glenohumeral kinematics.\textsuperscript{18,30} Alteration of scapular motion increases the demand on the rotator cuff musculature and metabolic cost of reaching forward and decreases maximal rotator cuff strength.\textsuperscript{4,7} Loss of normal posterior tilting appears to be associated with impingement in patients.\textsuperscript{12,14} Although it is not clear whether these alterations are the cause or the result of the shoulder injury, most authors believe that they should be addressed in the overall evaluation and treatment program.\textsuperscript{6,9,16,28,31}

Warner et al\textsuperscript{29} used the general term scapular dyskinesis collectively to describe the qualitative fact that, on Moire topographic analysis, the scapula on the affected side exhibited a different position and motion characteristics than on the unaffected side. Other terms, such as lateral scapular slide, scapular tilting, and scapular winging, have been used to describe abnormal movement patterns.\textsuperscript{6,8} These terms do not attempt to delineate possible patterns of altered scapular motion. The lack of common nomenclature hinders communication among medical professionals and does not provide guidance for understanding the scapular mechanical abnormalities possibly contributing to a patient’s condition. This study demonstrates that separate categories of scapular dyskinesis can be observed and described. As with any new system, there is room for refinement, but this initial study indicates that the categories appear to have some discriminatory capability, even when presented to blinded observers newly introduced to the evaluation system.

The availability of 3-dimensional analysis of the scapula has recently provided valuable insight into the normal and abnormal function of the scapula.\textsuperscript{1,7,13,14} Three-dimensional biomechanical analysis of normal scapular motion reveals that the scapula moves simultaneously about 3 axes of rotation as well as translates. The scapula normally tilts posteriorly and rotates medially and upwardly as the arm elevates.\textsuperscript{7,13,17} Previous studies of scapular motion in patients with impingement syndrome have shown a lack of posterior tilting and an increased superior translation with the use of 3-dimensional kinematic analysis and have suggested that abnormal scapular kinematics may be a major contributing factor to the shoulder pathology.\textsuperscript{12,14} These scapular abnormalities would be clinically categorized by this evaluation method as inferior angle prominence (type I pattern), indicating anterior tilting of the scapula, and a superior border prominence (type III pattern), indicating excessive motion of the superior scapular border. Continued investigation to validate this clinical evaluation system with 3-dimensional analysis is needed to ensure that clinical observations match the biomechanical scapular alterations.

This clinical evaluation attempts to provide clinicians with an in-office method with which to identify scapular dyskinesis and to categorize patients with scapular dyskinesis into more specific patterns. This assessment can be easily performed within the confines of a standard clinical evaluation. Patient evaluation from the back with visual access to the spine and both scapulae and arms allows examination of thoracic kyphosis, scoliosis, shoulder drooping, or abnormal scapular resting position. Three bony scapular landmarks—the inferior medial angle, the superior medial angle, and the posterior acromial edge—are primarily used to determine scapular pattern abnormalities. Dynamic scapular evaluation involves observing scapular motion as the arms are elevated and lowered in any plane. We chose the frontal and scapular planes because these were the most commonly studied planes.\textsuperscript{5,15,22} The patterns are usually more pronounced upon arm lowering, because of the extra load on the eccentrically activated muscles. Most patterns will present clear-cut predominance of one type of dyskinesis, but patients may show combinations of the patterns because of the scapular movement in 3 dimensions. The most common combination appears to be type III on arm ascent and type I on descent. In these cases, the type I pattern appears to predominate on multiple repetitions. In the situations in which the motions appeared to be mixed, we asked the evaluators to pick the scapular pattern by the type that is predominant during the entire arm raising/lowering cycle.

In this study no attempt was made to seek any correlation between the observed patterns of dyskinesia and specific shoulder injuries. The aim of this study was to develop a reliable clinical observational tool, similar to the load-and-shift or relocation maneuver, which describes abnormal motion independent of specific pathological causation. If this observational tool becomes reliable and valid, it is possible that future studies could attempt to demonstrate a correlation. However, the specific associations of scapular dyskinesis patterns and shoulder diagnoses are unlikely. First, frequently, more than one shoulder diagnosis is present in any one patient (eg, SLAP [superior labrum anteroposterior] lesion, rotator cuff tear, instability).\textsuperscript{24,25} Second, scapular alterations in scapular control are most commonly the result of muscular imbalance or abnormal activation patterns. These alterations are not associated with a specific diagnosis. Third, alterations in scapular posture to avoid painful shoulder positions or as a consequence of acquired adaptations occur independent of a specific diagnosis. Scapular dyskinesis is more likely to be a
clinically observable indication of coordinated shoulder control rather than a diagnostically specific test.

Because of issues of practicality and logistics, it was necessary to use videotape records of the subjects involved. Video is never as good as actual visualization. It does not allow the clinician to change viewing angles at will in order to visualize the scapular movement better, and therefore, the agreement between clinicians is somewhat compromised. However, video allowed the utilization of experienced clinicians who do not work in our practice to minimize bias resulting from familiarity with the evaluation system and the patients. This method has been previously used during observation of analysis of gait.3,10

κ Coefficients were used in this study because they measure agreement of categorical data.2,11 Our range of values of 0.31 to 0.59 places the strength of agreement in the fair to moderate range.11 This is comparable to findings in other studies.3,23 Eastlack et al3 found κ values ranging from 0.11 to 0.52 from video observational gait analysis that categorized the amount of knee motion during gait as normal, excessive, or inadequate. They concluded that video analysis had promise but that a more standardized approach to implementing gait analysis with emphasis on normal would increase reliability. Sjoden23 reported intraobserver agreement using to assess the Neer and AO classification systems for proximal humerus fractures. The reliability of the Neer system had a mean κ of 0.43, with a range of 0.2 to 0.85, and the AO system had a mean κ of 0.26, with a range of 0.16 to 0.6. The author suggested that low reliability was a result of poor ability to translate an image into classification patterns, but the more experienced observers were more consistent with their classification. We concur that moderate values are not a sufficient basis for a classification system and are attempting to improve the level of agreement. We believe that this level of agreement results from several factors. First, there is the inherent difficulty in evaluating scapular motion, resulting from either unfamiliarity with observing scapular motion or difficulty in identifying bony landmarks. More familiarity with the evaluation system for scapular dysfunction would be expected to improve results. A 10-minute familiarization presentation appears inadequate to explain the technique and educate an individual fully. Second, the descriptions of the 4 patterns may be difficult to comprehend. The various axes and planes of scapular rotation are not commonly used in the evaluation of shoulder dysfunction. Improved diagrammatic depiction of these terms could improve understanding and, therefore, recognition. Third, the possibility of combined patterns exists because of a patient’s individual adaptations and large capacity of various positions. Increasing the number of repetitions close to 10 arm elevation/lowering cycles usually produces a predominant pattern in clinical practice that may have been unclear with the 3 repetitions used in this study. Finally, the videotape does not allow viewing from multiple angles, and it presents limited information, describing scapular 3-dimensional motions by the use of 2-dimensional video. Further investigations with this system are being pursued to address these limitations.

This evaluation system of observation provides a simple, noninvasive, and relatively rapid method of assessing various patterns of scapular dyskinesis, an important and common component of shoulder dysfunction. This system attempts to create a common basis for clinical evaluation and description of scapular dyskinetic patterns, from one observer to another. This evaluation system does not constitute a classification system as it is presently developed. There is no evidence of correlation of these patterns with specific diagnosis nor do they suggest guidelines for treatment. These patterns can potentially represent a portion of the diagnosis of shoulder problems rather than a specific shoulder injury diagnosis. Further studies to validate these clinical observations and relate patterns with shoulder muscle activation patterns and methods to improve agreement should be pursued.

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