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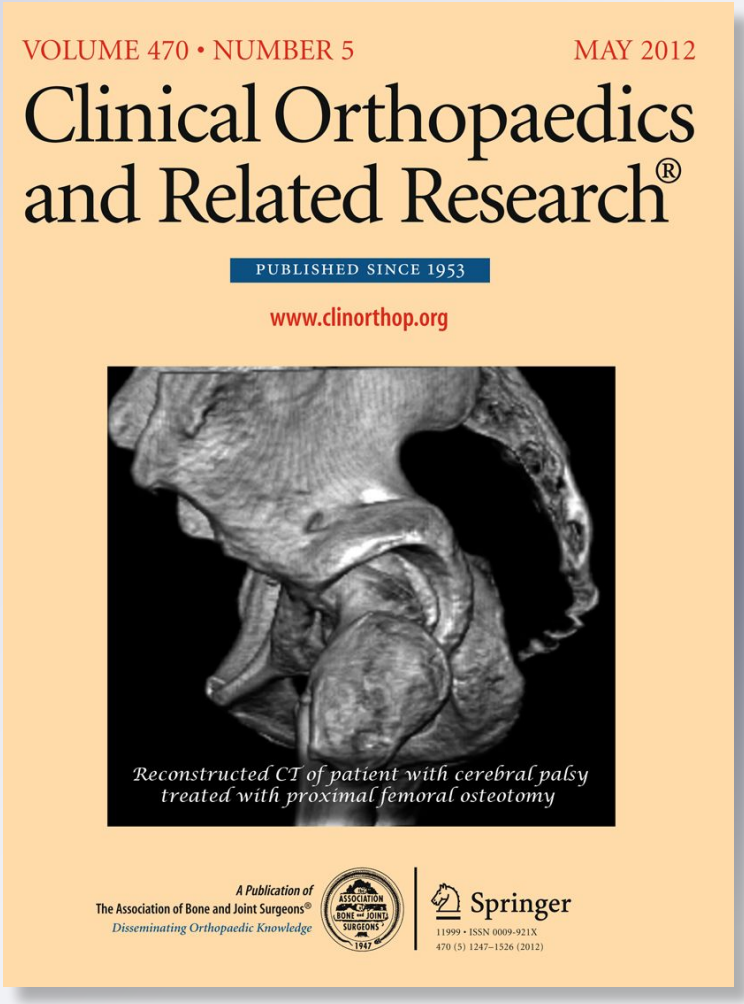

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SYMPOSIUM: INJURIES IN OVERHEAD ATHLETES

Reliability of Scapular Classification in Examination of Professional Baseball Players

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Abstract

Background Clinically evaluating the scapulothoracic joint is challenging. To identify scapular dyskinesis, clinicians typically observe scapular motion and congruence during self-directed upper extremity movements. However, it is unclear whether this method is reliable.

Questions/purposes We therefore determined the interrater reliability of a scapular classification system in the examination of professional baseball players.

Methods Seventy-one healthy uninjured professional baseball players between the ages of 18 and 32 years volunteered to participate. We used a digital video camera to film five repetitions of scapular plane elevation while holding a 2-pound weight. Four examiners then independently classified the motions on video into one of four types. Interrater reliability analysis using the kappa (k) statistic was performed for: (1) classifying each scapula into one of the four types; (2) classifying each scapula as being abnormal (Types I–III) or normal (Type IV); and (3) classifying both scapula as both being symmetric (both normal or both abnormal) or asymmetric (one normal, one abnormal).

Results We found low reliability for all analyses. In classifying each scapula as one of the four types, reliability was k = 0.245 for the left limb and k = 0.186 for the right limb. When considering the dichotomous classifications (abnormal versus normal), reliability was k = 0.264 for left and k = 0.157 for right. For bilateral symmetry/asymmetric, reliability was k = 0.084.

Conclusion We found low reliability of visual observation and classification of scapular movement.

Clinical Relevance Current evaluation strategies for evaluating subtle scapular abnormalities are limited.

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Each author certifies that his or her institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

This work was performed at Physiotherapy Associates Scottsdale Sports Clinic, Scottsdale, AZ, USA.

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Level of Evidence Level III, diagnostic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

Biomechanical research outlining the complex interaction between the scapulothoracic and glenohumeral joints during humeral elevation has resulted in descriptive data and identified consistent patterns of motion and interrelated movements between the scapula and humerus [1, 11]. Upward rotation, external rotation, and posterior tilting of the scapula are reportedly necessary for successful humeral elevation [1, 9, 11]. These movements, although objectively measurable in the laboratory setting with complex instrumentation such as three-dimensional tracking [1, 9, 11], are typically evaluated by clinicians in patients with shoulder dysfunction using only visual observation. Clinical decision-making regarding the presence or absence of scapular dysfunction or dyskinesis is made on that basis [5, 12, 18]. Various authors [6–8] defined scapular dyskinesis as "an observable alteration of the position and motion of the scapula relative to the thoracic cage." The descriptive term scapular winging refers to the severe dissociation of the scapula from the thoracic wall and is most often caused by loss of function of the long thoracic nerve [6, 7, 14]. More detailed descriptions of subtle scapular dysfunction and classifications appear in several publications by Kibler and colleagues [6–8, 19].

Evaluation of the scapula in the overhead athlete is of particular importance to clinicians as a result of the repetitive demands inherent in movement patterns like the throwing motion [2] and tennis serve [9, 16] and the requirement of high levels of scapular muscle activation to stabilize the scapulothoracic articulation and optimally position the glenoid to maximize glenohumeral congruity [6, 7]. Additionally, overhead athletes often present with subtle scapular dysfunction, not gross disassociation of the scapula away from the thorax as is seen in patients with nerve injury and other conditions [6, 7, 19]. Use of a classification system to evaluate subtle scapular dysfunction has been advocated and requires study on this population of overhead athletes who present with subtle scapular movement deviations in laboratory studies [5, 9, 10, 13, 15].

Kibler et al. [8] published a classification system for scapular dyskinesis in symptomatic patients for use during clinically practical visual observation. This classification system consists of three abnormal patterns and one normal pattern of scapular motion. Type I, or inferior angle prominence, is present when increased prominence or protrusion of the inferior angle (increased anterior tilting) of the scapula is noted along a horizontal axis parallel to the scapular spine [8]. Type II or medial border prominence is present when the entire medial border of the scapula is more prominent or protrudes (increased internal rotation of the scapula) representing excessive motion along the vertical axis parallel to the spine. Type III or superior scapular prominence occurs when excessive upward motion (elevation) of the scapula is present along an axis in the sagittal plane. Type IV is considered to be normal scapulohumeral motion with no excess prominence of any portion of the scapula and motion symmetric to the contralateral extremity. These authors found kappa (k) coefficients of 0.4 for intratester reliability and 0.5 for interrater reliability using this classification system [8]. They suggested that with refinement, this classification and observation method for assessing scapular motion might allow clinicians to standardize scapular evaluation and better identify dynamic scapular dysfunction patterns.

Therefore, this study was designed to determine the interrater reliability of the classification system of Kibler et al. [8] for scapular dysfunction in healthy, uninjured professional baseball players. Specifically we considered the interrater reliability of classifying each scapula into one of the four types, classifying each scapula as being abnormal (Types I–III) or normal (Type IV) and classifying both scapula as both being symmetric (both normal or both abnormal) or asymmetric (one normal, one abnormal).

Materials and Methods

We recruited 71 pitchers (n = 57) and catchers (n = 14) from the Milwaukee Brewers Baseball Club during spring training. All were free from known shoulder injury in the past year and presented to spring training able to participate in the upcoming season of professional baseball. Players were between 18 and 32 years of age. There were 58 right hand-dominant players and 13 left hand-dominant pitchers. All catchers were right hand-dominant. Subjects were videotaped after the signing of an informed consent as part of their spring training physical under the direction of the teams' certified athletic trainer. The study design was reviewed and approved by the Institutional Review Board of Physiotherapy Associates (Exton, PA, USA).

Subjects were instructed to stand assuming a normal resting posture and given a 2-pound dumbbell in each hand. Subjects were positioned 10 feet directly in front of a video camera (Sony Handycam, Tokyo, Japan) that was mounted level on a tripod 4 feet from the floor. Subjects removed their shirts and were positioned with their backs to the camera so that they could not be identified on the video recording. Before initiation of testing, a paper with the subject's sequentially assigned research number was filmed

to allow for identification and future analysis of each subject solely by number. Subjects were instructed to elevate their shoulders using a 4-second count into maximal scapular plane elevation with a 1-second pause in full elevation followed by a 4-second eccentric lowering of the extremities to the starting position. Five full repetitions were performed and used for observation and analysis. This scapular test has been recommended and used in the literature for evaluating scapular humeral rhythm in athletes and in patients with glenohumeral dysfunction [7, 8, 12, 18, 19].

After filming was completed in all 71 subjects, the videotape was copied and distributed to two orthopaedic surgeons (WBK, DSB) and two physical therapists (GJD, TSE) specializing in shoulder and elbow disorders. These four examiners were familiar with and had used the scapular classification system outlined by Kibler et al. [8] in their clinical practices and had a mean of 27.5 years treating shoulder and elbow disorders in overhead athletes. The instructions to each examiner were to view the subjects on the videotape and record the scapular classification type (I–IV) for each scapula (an illustrative supplemental video is available with the online version of CORR). Examiners were allowed to rewind and review the tape as needed to simulate the clinical setting where examination involves the observation of multiple repetitions of arm elevation to enhance clinical decision-making. After independently forwarding the results to the primary investigator, the data were analyzed to determine interrater reliability of the scapular classification system.

Interrater reliability was examined using the generalized k statistic [3] for multiple raters for three separate analyses: (1) classifying each scapula into one of the four types (I–IV); (2) classifying each scapula as being abnormal (Types I–III) or normal (Type IV); and (3) classifying both scapula as both being symmetric (both normal or both abnormal) or asymmetric (one normal, one abnormal) [19]. Ninety-five percent confidence intervals were computed using the product of the corrected kappa standard error [4] and 1.96 [17].

Results

We found low interrater reliability was revealed for all analyses. In classifying each scapula as one of the four types, reliability was k = 0.245 (95% CI, 0.176–0.315) for the left upper extremity and k = 0.186 (95% CI, 0.111–0.261) for the right upper extremity. When considering the dichotomous classifications, abnormal (Types I–III) versus normal (Type IV), reliability was k = 0.264 (95% CI, 0.130–0.399) for the left and k = 0.157 (95% CI, 0.049–0.265) for the right. To test for the ability of the examiners to reliably identify bilateral symmetry/asymmetry (scapular classification of the left side does or does not equal that on the right side), reliability was k = 0.084 (95% CI, −0.0132 to 0.300).

Discussion

The evaluation of the scapulothoracic joint is an integral part of both a preventive physical examination as well as during the examination of the injured overhead athlete [6, 7]. In the clinical setting, methods used to evaluate the scapula rely on visual observation and a keen understanding of the normal mechanics and pathomechanics of scapular motion. We used a clinical method of visual observation to evaluate uninjured professional baseball players for the presence of scapular dyskinesis using a scapular classification system recommended in the literature [6–8, 19]. The presence of subtle scapular dyskinesis identified in laboratory studies [13, 15] in overhead athletes coupled with the reported consequences of scapular dyskinesis on high-level overhead upper extremity function [6, 7, 9] highlight the importance of early identification and recognition of scapular pathology in overhead athletes to both prevent injury and optimize performance. The overall purpose of this study was to use a clinical method of visual observation to evaluate the scapula of uninjured professional baseball players to determine the interrater reliability of visual observation and the Kibler et al. [8] scapular classification system.

We recognized limitations to our study. First, scapular function and motion were not assessed on these players while performing their sport-specific movements such as throwing or pitching. Instead, a clinical method of scapular evaluation was used that involved elevation of the shoulder in the scapular plane using a 2-pound weight as has been advocated and studied elsewhere in the clinical and experimental literature [8, 12, 18, 19]. Second, the use of video recording and capture of the upper extremity movements rather than live evaluation may have limited the interpretation of scapular outline and full appreciation of some aspects of human scapular motion that are better captured with live observation. This method of using video recording of upper extremity movements has been used in the literature in other investigations and the quality of the video was not deemed a limitation by the examiners who were able to review and rereview each subject's repetitions. Additionally, it was not possible to have multiple examiners at the time of data capture and the use of video did allow for unbiased private evaluation of the data by each of the examiners truly in an independent manner. Lastly, the use of healthy uninjured players may have limited the identification of more obvious forms of scapular dyskinesis

typically reported and found in patients and athletes with shoulder injury [6–8]. The use of uninjured players was meant to best replicate the clinical challenge of early identification of players at risk for injury before a season of sport, a frequent clinical challenge encountered by orthopaedic surgeons and sports physical therapists and athletic trainers.

Several studies have begun evaluating the effectiveness of visual observation of scapular motion. McClure et al. [12] videotaped a sample of 142 uninjured athletes using the motions of flexion and coronal plane abduction with a 3- to 5-pound weight. Multiple raters viewed the videotape recording and rated the scapula as normal, subtle, or obvious dyskinesis. Their study produced k coefficients ranging between 0.48 and 0.61 with percentage agreement ranging between 75% and 82% between examiners (Table 1). They identified satisfactory reliability using this scapular classification system in overhead athletes. Tate et al. [18] performed an additional study to validate the scapular classification system used in the study by McClure et al. [12] using 66 of the same 142 subjects clinically analyzed in the McClure et al. study. Using three-dimensional electromagnetic kinematic testing, Tate et al. [18] revealed less scapular upward rotation and less clavicular elevation in subjects classified with obvious dyskinesis compared with those classified with normal scapular motion. The study by Tate et al. [18] demonstrated the important objective relationship identified between three-dimensional electromagnetic kinematic testing and observationally based scapular evaluation in overhead athletes. Uhl et al. [19] measured 56 subjects, 35 of which had been diagnosed with shoulder injury on clinical examination and/or imaging studies using both a "yes/no" and "four-type" (Kibler Type I, II, III, IV) classification system to document scapular dyskinesis. Two blinded examiners rated the subjects using both methods of categorization, which resulted in k coefficients of 0.40 for the yes/no method of evaluating scapular dyskinesis and 0.44 for the "four-part" method. The percent agreement for the two methods were 79% and 61% for the yes/no and four-part methods, respectively. Uhl et al. [19] also used a three-dimensional tracking method to objectively quantify scapular motion on each subject. They compared the visual observation classifications with the objective tracking data and found each method to have sensitivity values of 74% to 78% (yes/no) and 10% to 54% (four-part), whereas specificity values ranged between 38% and 31% (yes/no) and 62% and 94% (four-part). Uhl et al. [19] used both flexion and scapular plane elevation movements in their study. Interestingly, they reported more multiple plane scapular movement asymmetries in the symptomatic population (54%) in flexion compared with asymptomatic (14%) subjects. The flexion movement pattern identified abnormal scapular movement in both symptomatic and asymptomatic populations. Our study only used the scapular plane elevation position. Differences between the Uhl et al. [19] study and our present research include analysis of "live" versus videotaped evaluation of the subjects as well as the comparison between two examiners by Uhl et al. [19] and the use of four examiners in our present study. This might partially explain the lower k values generated in our present research using the same four-type Kibler system and dichotomous classifications.

Table 1. Summary of findings for visual observation of scapular dyskinesis

Study/Source	Kappa value
McClure et al. [11]	0.48–0.61
Uhl et al. [19]	
4-part classification	0.44
Yes/no classification	0.40
Current study	
4-part classification	0.18–0.25
Yes/no classification	0.16–0.26

Several studies have identified alterations in scapular movement in healthy uninjured overhead athletes [10, 13, 15]. Myers et al. [13] measured increased scapular upward rotation, internal rotation, and retraction in throwing athletes on their dominant throwing extremity as compared with a control group of nonthrowers. Laudner et al. [10] tested baseball pitchers and position players and found the pitchers had less scapular upward rotation on their dominant arm at 60° and 90° of scapular plane elevation compared with position players. This decrease in upward rotation may compromise the acromiohumeral interval during overhead motion and increase injury risk in individuals in this population. Finally, Oyama et al. [15] measured scapular posture in a population of 43 overhead athletes. They found greater scapular protraction in tennis players on the dominant shoulder than on the nondominant side. Additionally, in all the overhead athletes (baseball pitchers, volleyball players, and tennis players), the dominant scapula was more internally rotated and anteriorly tilted than the nondominant side. These studies all show alterations in dominant arm scapular motion in overhead-throwing athletes. Unilateral repetitive overhead activity coupled with extreme ROM demands throughout the upper extremity kinematic chain is believed to result in musculoskeletal adaptations that have been documented with laboratory-based research methods.

We found low reliability between experienced examiners using the Kibler scapular classification system for professional baseball pitchers and catchers without known shoulder pathology. The subtle adaptations and absence of shoulder injury may have complicated the ability of the

examiners to more clearly identify the subtle scapular adaptations and dyskinesis patterns that may accompany these athletes. Further testing of both the four-part and yes/no classification on injured overhead athletes is needed to further understand the optimal method for identifying and classifying scapular pathology that is commonly associated with overuse injury in the overhead athlete. Further research is needed to best determine the humeral elevation positions and load additions and classification system to most reliably and accurately identify scapular pathology in a clinically based environment.

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