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Intra-Rater and Inter-Rater Reliability and Agreement of the Scapular Dyskinesis Test in Young Men with Forward Head and Round Shoulder Posture

Mohammad Bayattork[1, 2], MSc; Foad Seidi[2]*, PhD; Hooman Minoonejad[2], PhD; Philip McClure[3], PhD; Esmaeil Mozafaripoor[2], PhD

[1]Sport Sciences and Physical Education, Faculty of Humanities Science, University of Hormozgan, Bandar Abbas, Iran
[2]Health and Sports Medicine Department, Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran
[3]Arcadia University, Department of Physical Therapy, Glenside, PA, USA

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ABSTRACT

Background: Forward head and round shoulder posture (FHRSP) is believed to be related to scapular dyskinesis (SD), placing increased stress on the neck and shoulder, leading to pain and dysfunction. Therefore, a clinical method with sufficient reliability to distinguish normal and abnormal scapular position and motion among people with FHRSP is called for. This study aims to evaluate intra-rater and inter-rater reliability and agreement of the scapular dyskinesis test (SDT) in people with FHRSP.

Methods: This reliability study included 60 young men who were identified as having FHRSP, having been measured by the photogrammetry method. The clinical examination included a Scapular Dyskinesis Test (SDT), which is a dynamic and visually based test to classify the presence of SD. It was performed by two raters who were blinded to each other's test results on two different days. Intra- and inter-rater reliabilities were determined using the Kappa coefficient with linear weighting for the ordinal classification of SD by SDT.

Results: Inter-rater agreement values ranged from 90.8% to 92.1%. Furthermore, the inter-rater reliabilities presented an almost perfect reliability (k>0.82). For intra-rater agreement, raters presented high percentage values of agreement between the two measurements (88.9% to 92.5%). Intra-rater reliability for raters was substantial to almost perfect (k>0.77).

Conclusion: The intra- and inter-rater reliability and agreement of the SDT obtained by two raters was substantial to almost perfect among young men with FHRSP. Therefore, it seems that SDT is a simple method to distinguish normal and abnormal scapular position and motion in order to screen or assess before developing prevention programs.

Introduction

Proper posture is considered as a condition of musculoskeletal balance, in which the stress and strain on the body is minimized [1]. Deviation from normal alignment suggests the presence of imbalance and abnormal strain and pressure on the musculoskeletal system [2]. The forward head and round shoulder posture (FHRSP) is one of the commonly recognized abnormal postures in the sagittal plane, which is defined as a combination of lower cervical flexion, upper cervical extension, and rounded shoulders [3]. Such a posture is associated with altered scapular positions, kinematics, and muscle activities [3-5], and these visible altered patterns have been termed scapular dyskinesis [6].

*Corresponding author: Foad Seidi, Health and Sports Medicine Department, University of Tehran, North Kargar, Zip Code 13117, Tehran, Iran. **Tel:** +98 9126781740; *Email:* foadseidi@ut.ac.ir

Moreover, head and shoulder postural malalignments are thought to influence the muscular balance surrounding the shoulder and may lead to some common characteristics found in patients with shoulder impingement [7].

Previous studies found that altered scapular alignment and kinematics change the force transmission and may be associated with shoulder instability and injuries [8, 9]. Moreover, a recent review study mentioned a cause-consequence relationship between scapular dyskinesis (SD) and neck or shoulder pain, and the authors suggested that the therapist should be the one to always observe, examine and treat SD in patients with shoulder and neck problems [10]. Thigpen et al. found that individuals with FHRSP displayed greater scapular internal rotation as well as anterior tilting, which is usually seen in the SD, throughout the flexion task [11]. Therefore, given the association of FHRSP with alteration in scapular kinematics and muscle activity and to identify a potential subset related to abnormal scapular position and motion patterns, clinical methods to distinguish normal and abnormal scapular positions and motion are required.

Some clinical tests have been developed to identify SD [12], which in the scapular dyskinesis test (SDT) is a dynamic, visually based test [6]. In this test, the patient repeatedly performs active, weighted shoulder abduction and flexion to a 3-second count while the clinician observes the scapulohumeral rhythm. The presence of scapular dyskinesis is defined as abnormal movement patterns, either or both dysrhythmia (the scapula demonstrates premature or excessive elevation or protraction, non-smooth motion during arm elevation and/or lowering) and winging (medial border of the scapula and/or inferior angle of the scapula are posteriorly displaced away from the thorax). The final rating is based on the combined flexion and abduction test movements; the presence of SD is classified as either not present (normal) or present (subtle dyskinesis or obvious dyskinesis)[6].

Not only validity but also reliability is of concern regarding the application of clinical tests since a test will not be valid if not reliable [13]. The SDT classification system has shown moderate inter-rater reliability (weighted kappa 0.48-0.61, 75%-82% agreement) [6], and concurrent validity was demonstrated by a 3-dimensional motion tracking system among college athletes [14]. However, measurement properties may vary by setting and population so that athletes have been shown to demonstrate a different pattern of scapular kinematics than the general population [15]. Moreover, the participants in previous studies had a different range of shoulder symptoms [6, 12, 14]. Therefore, these findings cannot be generalized to general populations, especially people with abnormal head and shoulder posture, without any clinical signs and symptoms who pretend to pain or pathology, and further studies are needed to determine reliability and agreement of the SDT in the relevant population. Also, a recent review identified a lack of high-quality studies evaluating intra as well as inter-rater reliability of tests used for the assessment of scapular dyskinesis [13]. Intra as well as inter-rater reliability, both provide valuable information for clinicians. Besides, identifying a potential subset related to abnormal scapular position and motion patterns in people with FHRSP may provide important evidence to develop neck and shoulder problem prevention programs. Also, SDT is likely to be performed in routine care very frequently to identify people in need of specific postural improving programs, to evaluate the improvement of scapular position and motion in people who had received intervention and to monitor their status.

Therefore, the objectives of the present study were to evaluate intra-rater and inter-rater reliability and agreement of the SDT in people with FHRSP. We hypothesized that at least moderate levels of intra-rater and inter-rater reliability and agreement of the SDT would be established.

Methods

Study Design and Participants

This was a reliability study consisting of an inter-rater and intra-rater reliability assessment using two investigators (M.B., E.M) and conducted over two days. One hundred and nine young men were screened for this study and finally, 60 people who demonstrated FHRSP (24.6±3.0 years, 173.5±6.8 cm tall, 78.6±8.5kg, and body mass index, or BMI, 23.3±2.8 kg/m2) were recruited. The participants were recruited by verbal invitation and advertisements in bulletin boards from the students of the University of Tehran. The project was part of a larger study that was approved by the Ethics Committee on Research at the University of Tehran. Before testing, all study participants signed a consent form. Inclusion criteria were being older than 18 years of age and having a forward head angle higher than 45 and round shoulder angle greater than 50 as measured by using a photogrammetry method (Figure 1) according to the procedure described by Seidi et al. [16]. Participants were excluded from the research process if they had a history of fracture, surgery, or joint diseases in the neck and shoulder; had a body weight outside the normal range (BMI between 18 and 25); or had neck or shoulder pain during arm elevation, rating of 3/10 or higher on a numeric rating scale.

Procedures

The clinical examination included an SDT assessment according to the procedure described by McClure et al. [6]. In this test, participants were asked to remove their shirts during the study to allow observation of the posterior thorax and scapula, and they were asked to perform five repetitions of bilateral active shoulder flexion and five repetitions of bilateral shoulder abduction (Figure 2). Dumbbell weighted test movements were performed according to body weight (1.5 kg for those weighing less than 68 kg and 2.5 kg for those weighing 68 kg or more); movements were performed on a 3-second count when elevating and lowering the arms. A metronome was used to control the duration of the movements. The examiners observed test movements while standing

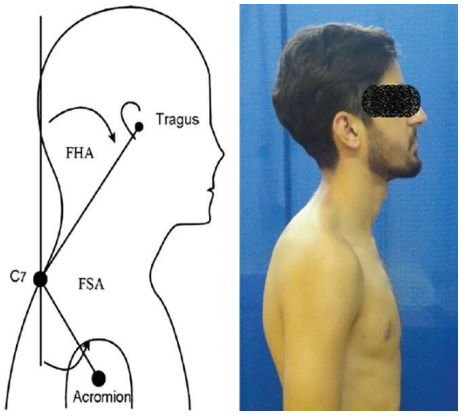

Figure 1: Measurement of forward head/shoulder angles- FHA: Forward Head Angle, FSA: Forward Shoulder Angle

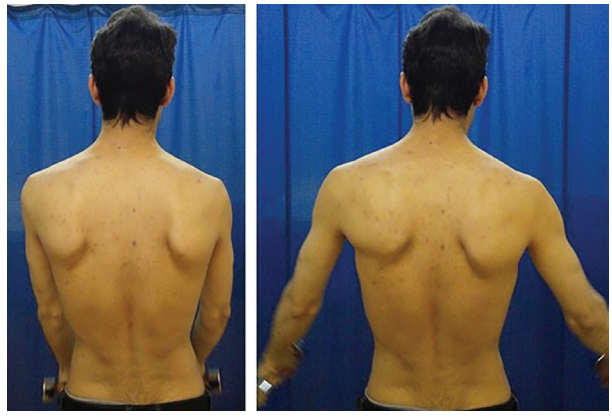

Figure 2: Scapular dyskinesis test measurement

behind the patient, and the scapulohumeral rhythm was classified as either normal, subtle dyskinesis, or obvious dyskinesis. The scapular dyskinesis screening form was shown in Appendix 1 [6]. Clinical examinations were performed by two raters who were Ph.D. students at the Health and Sports Medicine Department, University of Tehran, with three years of clinical experience as part of their clinical training. Before starting the study, the raters completed a brief standardized online training program http://gargoyle.arcadia.edu/ur/pt/Scapular_Dyskinesis_Test.pdf. The raters performed the test simultaneously, and independently, i.e., were blinded to each other's test results. After one day, the assessment protocol was repeated to determine intra-rater agreement and reliability. The raters were also blinded to their own prior findings of the test under evaluation.

Statistical Analysis

Data analysis was performed using Statistical Package for Social Sciences (SPSS) software (version 21, SPSS, Inc, Chicago, IL USA). The percentage of agreement was calculated by dividing the observed agreement by the total number of observations, which indicated how identical the repeated measurements were, i.e., the degree to which the two raters agreed with each other (inter-rater agreement), the consistency of grading by a single rater (intra-rater agreement) [17, 18]. Intra- and inter-rater reliabilities were determined using the Kappa coefficient with linear weighting for the ordinal classification of SD by SDT. The Kappa coefficient range was 0 to 1, wherein the agreement strength followed these values: <0, poor; 0.01±0.20, slight; 0.21±0.40, fair; 0.41±0.60, moderate; 0.61±0.80, substantial; and 0.81±1, almost perfect [17, 18].

Two factors that can influence the magnitude of the Kappa coefficient include 1) the prevalence index that reflects the prevalence of an attribute and 2) the bias that is the extent to which the raters disagree on the proportion of positive cases. Therefore, these factors should be taken into account in interpreting the Kappa values [18]. The prevalence index was calculated by estimating the difference in the proportion of agreement on the positive and negative cases for the two testers (inter-rater reliability) and two assessments (intra-rater reliability). The values range from −1 to +1, where 0 indicates an equal probability of positive and negative cases [19]. The bias index was calculated by estimating the difference in proportions of positive cases between the two testers or two assessments with the absolute values ranging from 0 to 1, where 0 indicates equal marginal proportions [19]. Obvious and subtle SDT classification were defined as positive cases for index calculations.

Results

Table 1 shows some demographic characteristics of included participants. The percentage of agreement, intra-rater and inter-rater reliabilities (Kappa coefficients) for the SDT with the number of participants classified with SDT by each examiner are shown in Table 2 and 3. Out of 60 participants, 33% to 52% were categorized as having SD during rest position and arm movements. The SDT presented inter-rater agreement values ranging from 90.8% to 92.1%. Furthermore, the inter-rater reliabilities had almost perfect reliability (k>0.82). For intra-rater agreement, raters 1 and 2 presented high percentage values of agreement in the two measurements (88.9% to 92.5%). Intra-rater reliability for rater 1 was substantial to almost perfect (0.77±0.84) and for rater two it was almost perfect (0.82±0.88). The prevalence index for both inter-rater and intra-rater reliabilities presented mostly small negative values, i.e., no prevalence effect. Also, the bias index showed values very close to zero, indicating no difference in proportions of positive cases between the two raters or between the two assessments of each rater (Table 2 and 3).

Table 1: Demographics characteristics of participants (n=60)

	Mean	SD
Age (years)	25.3	2.5
Hight (Cm)	176.8	7.2
Weight (Kg)	77.7	2.5
BMI	23.6	0.8

BMI: Body Mass Index ($kg\,m^{-2}$)

Discussion

The present study aimed to evaluate intra-rater and inter-rater reliability and agreement of SDT in people

Table 2. Number (percentage) of participants diagnosed as having SD by each examiner and Inter-rater agreement and reliability of SDT (n=60)

Position	Presence of SD n (%)		Percentage of agreement	Kappa Coefficient (95% CI)	Prevalence Index	Bias Index
	Rater 1	Rater 2				
Rest	20 (33.3%)	21 (35%)	92.1	0.82 (0.68±0.94)	-0.24	0.01
Flexion	31 (51.6%)	30 (50%)	90.8	0.89 (0.79±1.00)	-0.12	0.06
Abduction	28 (46.6%)	29 (48.3%)	91.3	0.87 (0.76±0.96)	0.02	0.00

Table 3: Intra-rater agreement and reliability of SDT (n=60) by two examiners

Position	Percentage of agreement		Kappa Coefficient (95% CI)		Prevalence Index		Bias Index	
	Rater 1	Rater 2	Rater 1	Rater 2	Rater 1	Rater 2	Rater 1	Rater 2
Rest	90.6	92.5	0.77 (0.61±0.89)	0.82 (0.69±0.97)	-0.21	-0.23	0.07	0.05
Flexion	91.2	88.9	0.81 (0.66±0.93)	0.86 (0.74±0.95)	-0.13	-0.11	0.04	0.02
Abduction	89.7	91.4	0.84 (0.75±0.94)	0.88 (0.77±1.00)	0.06	0.02	0.00	0.01

with FHRSP. We found the intra-rater and inter-rater reliability to be substantial to almost perfect.

The inter-rater reliability and agreement values observed in the present study are in line with those reported by McClure et al., and with those of prior studies evaluating other dynamic and visually based scapular tests indicating moderate to almost perfect inter and intra-rater reliability at best [6, 12, 20]. However, reliability and agreement parameters are influenced by several factors, and the need for caution is stressed when comparing kappa values across studies and using different test procedures, prevalence rates, or scales [18]. The original study by McClure et al., presented moderate and substantial inter-rater reliabilities (Kappa, 0.48±0.61) and agreement percentage from 75% to 82%, based on live evaluation and videotape in healthy overhead athletes [6]. Moreover, Rosi et al. showed high-reliability values for both intra-rater and inter-rater evaluation throughout a protocol that provided SD evaluation training of raters and included several repetitions of arm movements with a external load during a live assessment [21]. Our findings are also in agreement with results from Christiansen et al. in which the levels of intra-rater and inter-rater reliability and agreement of the SDT was moderate to almost perfect [12]. However, their study was done among patients with symptoms of subacromial impingement, and they mentioned the presence of SD as classified by the SDT seems to be of limited value in the planning of treatment for patients with subacromial impingement syndrome because the presence of SD was not predictive of outcome.

To the best of our knowledge, the present study is the first to evaluate the intra-rater and inter-rater reliability and agreement of the SDT, specifically among people with verified FHRSP. The relatively small differences between the two raters' intra-rater agreement levels should be noted. Our results indicate that the SDT test and the classification were interpreted similarly by the two raters because the main factors mentioned in previous studies for improving agreement were applied in this study. The present study acted on the suggestion by McClure et al. to add external load to the movement as the loading is applied to provoke abnormal scapular motion due to the fact that muscular fatigue increases compensatory strategies [6]. Moreover, our examiners were previously trained by using the authors' operational definitions and the photos and videos compiled by McClure et al. that demonstrated normal and abnormal scapular positions and motions [6].

The present study has some strengths and limitations. Our sample size fulfilled the general recommendation where at least 50 subjects should be recruited to evaluate the reliability and agreement of a test [22]. Reliability was measured in men only as it was part of a large-scale pre-participation screening study in men, so research in women is necessary. The SDT was not compared with a gold standard 3-dimensional kinematic analysis, so further research on validity is required. Finally, our findings can be generalized only to people with verified FHRSP.

Conclusion

The levels of intra-rater and inter-rater reliability and agreement of the SDT obtained by two raters was substantial to almost perfect among young men with FHRSP. Therefore, it seems that the SDT is a clinical and straightforward method to distinguish normal and abnormal scapular position and motion among people with neck and shoulder malalignment in order to screen or assess before developing prevention programs.

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Conflict of interest: None declared.

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Appendix 1: Scapular dyskinesis screening form

Scapular Dyskinesis Screening

Operational Definitions

Normal scapulohumeral rhythm: The scapula is stable with minimal motion during the initial 30° to 60° of humerothoracic elevation, then smoothly and continuously rotates upward during elevation and smoothly and continuously rotates downward during humeral lowering. No evidence of winging is present.

Scapular dyskinesis: Either or both of the following motion abnormalities may be present.

Dysrhythmia: The scapula demonstrates premature or excessive elevation or protraction, non-smooth or stuttering motion during arm elevation or lowering, or rapid downward rotation during arm lowering.

Winging: The medial border and/or inferior angle of the scapula are posteriorly displaced away from the posterior thorax.

Single Plane Rating Scale

Normal Motion: no evidence of abnormality in either plane of motion

Subtle abnormality: mild or questionable evidence of abnormality, not consistently present

Obvious abnormality: striking, clearly apparent abnormality, evident on at least 3/5 trials (dysrhythmias or winging of 1 in or greater displacement of scapula from thorax)

Single Plane Flexion Rating			Single Plane Abduction Rating		
☐ Normal	☐ Subtle Dyskinesis	☐ Obvious Dyskinesis	☐ Normal	☐ Subtle Dyskinesis	☐ Obvious Dyskinesis
Identify primary type of dyskinesis present for selected rating in each plane					
	☐ Dysrhythmia ☐ Medial border ☐ Inferior Angle			☐ Dysrhythmia ☐ Medial border ☐ Inferior Angle	

Final Rating Scale

Normal: both test motions are rated as normal or 1 motion is rated as subtle

Subtle abnormality: both flexion and abduction are rated as subtle

Obvious abnormality: Either motion is rated as having obvious abnormality

Final Rating		
☐ Normal Motion	☐ Subtle Abnormality	☐ Obvious Abnormality