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Reliability of Posterolateral Acromion Process to Examination Table Measurement to Estimate Shoulder Protraction Contracture

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ABSTRACT

Study Design: Retrospective study. **Objectives:** To determine the reliability of measuring the perpendicular distance between the posterolateral acromion process and examination table to estimate passive shoulder protraction in student physical therapists. **Background:** Previous research has identified scapular dyskinesis to be associated with musculoskeletal shoulder pain, and commonly addressed by physical therapists. Tightness of the anterior shoulder muscles may be associated with scapular movement abnormality. Thus, reliable clinical measurements for anterior shoulder muscle length are important for physical therapy care. **Methods:** After a 10-minute review session, two measurements of the distance between the posterior acromion process and examination table were obtained for both the dominant shoulders and nondominant shoulders in 12 nondisabled individuals (6 females, and 6 males age: 25.0 ± 2.4 years) by 12 student physical therapist examiners. A complete set of measurements from 10 subjects were available for analysis. **Results:** Mean (±standard deviation) measurements for the dominant (D) shoulder were 7.6 ± 2.0cm for Trial #1 and 7.4 ± 2.0 cm for Trial #2, and 7.5 ± 2.1cm for Trial #1 and 7.4 ± 2.3cm for Trial #2 for the nondominant (ND) shoulder. Tightness was determined in 85% and 86% for D and ND shoulders, respectively. The measurement demonstrated good intra-rater reliability (D: intraclass correlation, formula 2,1; $ICC_{2,1}$ .751, 95% confidence interval; CI: .628-.861; ND: .764, 95% CI: .645-.869) and moderate to good inter-rater reliability (D: $ICC_{2,1}$ = .651, 95% CI: .445-.876; ND: $ICC_{2,1}$ = .733, 95% CI: .548-.911) considered as a continuous variable, and good percent agreement both within raters (94%) and between raters (90%) as a binomial variable. The coefficient of variation was acceptable (D: 25.8, ND: 28.4%). Standard error of measure was 0.99 cm for D shoulders and 1.01 cm for ND shoulders. Minimum detectable change outside the 95% confidence interval was 2.74 cm for D shoulders and 2.80 cm for ND shoulders. **Conclusion:** Measurement of the perpendicular distance between the posterolateral acromion process and examination table is a reliable method to estimate passive shoulder protraction in novice clinicians.

Key Words: measurement reliability, shoulder, physical examination

INTRODUCTION

Pain related to shoulder pathology is a common form of disablement, affecting up to one-third of individuals during the life course.[1] The etiology of shoulder pain is multi-factorial and often clouded. Development of shoulder pathology has been associated with scapular dyskinesis. During shoulder girdle elevation, patients with scapular dyskinesis exhibit limited scapular external rotation and posterior tilt. As a result of these faulty kinematics, a decrease in subacromial volume is evident, with a greater likelihood of the soft tissues in the subacromial space becoming compressed.[2-7] Maladaptive shortening of the anterior shoulder musculature, including the pectoralis minor (PMi),[5,8,9] pectoralis major,[10] biceps brachii, and coracobrachialis[10,11] has been implicated as one cause of scapular dyskinesis. Excessive anterior movement of the humerus and clavicle imparted by contracture of the anterior musculature may draw the posterior capsule of the glenohumeral joint taut and force the scapula to anteriorly tilt and internally rotate as a compensatory movement during elevation.[12]

Previous studies have documented the properties of specific muscle length measurements that may be accountable for excessive passive shoulder protraction. Borstad and Ludewig[9] briefly reported on a measurement that was proposed as a specific PMi measurement, in which a clinician measures the distance between the 4th sternocostal junction and coracoid process. The data set consisted of pilot measurements of 6 nondisabled subjects. Validity and reliability data was not documented in this pilot study. However, data from a subsequent larger study of 11 cadaver specimens suggested this clinical measurement of PMi length demonstrated excellent concurrent validity with respect to direct cadaveric measurements.[1] Inter-rater reliability, intra-rater reliability, and sensitivity of change of this measurement has yet to be elucidated. This brings into question the readiness for this measurement to be implemented clinically. The specific palpation of the 4th intercostal space may be unreliable and considered personally invasive by some patients. In addition, a specific measurement for PMi length only addresses one potential cause of excessive shoulder protraction. A global screening assessment also may be clinically useful to identify the need for more specific muscle length assessment.

Kendall and colleagues[11] proposed to use the distance between the treatment table and posterior-lateral edge of the acromion with the patient positioned in supine as a clinical estimation of pectoralis minor tightness. It is also possible that contracture of other muscles could result in shoulder protraction, such as the pectoralis major, biceps brachii, coracobrachialis, and latissimus dorsi.[12] The serratus anterior, as the primary protractor of the shoulder, also could cause excessive shoulder protraction if tight. Thus, the test proposed by Kendall and colleagues[11] may best be considered a screening examination tool that could indicate the need for more specific muscle length assessment in the presence of a positive result. Lewis and Valentine[14] studied the posterior acromion to table distance in 45 asymptomatic subjects and 45 subjects with various shoulder pathologies, based on 3 measurements from

a single tester. No subject met the criteria for normal muscle length established by Kendall and colleagues, and the posterior acromion to table distance ranged between 5.9-6.3cm.[11] The range of measurements documented by Lewis and Valentine[14] (5.96-6.57 cm) also does not support the presence of individuals who were considered to have normal muscle length by Kendall and colleagues' criteria,[11] even among asymptomatic individuals measured in this study. Taken together, these studies suggest that continuous measurement of posterior acromion to table distance may be more clinically relevant than a categorical assessment of "tight" versus "not tight" based on acromion process position with respect to the table.

For clinicians to be able to treat various forms of scapular dyskinesis and prevent progression to more serious shoulder pathology, they must be able to identify and quantify patterns of muscular restrictions if they are to develop an accurate clinical hypothesis. Given the relative inexperience of novice clinicians, although evidence for construct validity is present, only one study provides evidence of adequate intrarater reliability among relatively experienced and specifically trained clinicians.[14] Inter- and intratester reliability among novice clinicians remains unknown. In addition, sensitivity to change also remains unclear for this measure. The purpose of this study was to determine the interrater reliability, intrarater reliability, and sensitivity to change of the posterior shoulder-to-table measurement for passive shoulder protraction among student physical therapists.

METHOD

This study involved a retrospective review of student physical therapist records that documented a laboratory exercise. The exercise was performed by 21 first year Doctor of Physical Therapy students. The Institutional Review Board at University of the Pacific (Stockton, CA, USA) approved this study.

Subjects

Participants were currently enrolled in the University of the Pacific's Doctor of Physical Therapy program and had successfully completed coursework leading up to the point of the study. Participants with known cervical or upper quarter pathology were excluded from the activity to ensure student safety. Twenty-two subjects were recruited to participate in this study, of which 10 were assigned to be subjects and 12 were assigned to be evaluators. There were 120 total observations available for analysis. Subjects included 4 females and 6 males aged 25.0 ± 2.4 years. Subjects self-designated 9 right shoulders and one left shoulder as the dominant shoulder.

Procedure

Subjects were instructed to lay supine on the treatment table in a comfortable position[11] (Figure 1). First year DPT students (n=12) served as testers. Testers were provided with a 10-minute review session to familiarize themselves with study measurements. Levels of measurement included categorical measurement (an estimation of whether the anterior shoulder musculature was "tight" versus "not tight." Tight would be identified by failure of the posterior lateral edge of the acromion to make contact with the table, in accordance with the operational definition provided by Kendall and colleagues,[11] as well as a continuous measurement using the cloth tape measure to the nearest 0.1 cm (Figure 1). The tape measure was placed at the distal-most extent of the posterior aspect of the acromion process at the zero point, and the perpendicular distance between this anatomical landmark and the treatment table was measured. Testers had previous experience with measurement in the context of a previous course. Testers were allowed to practice the measurement twice, but were given no feedback from instructors about the technique. At the conclusion of the training session, testers performed measurements on each subject. Testers were randomly assigned to the first subject, and then sequentially measured each subsequent subject in series. Testers were provided one minute with each subject to complete each measurement, which included each shoulder. The process continued until testers measured each subject twice.

Statistical Analysis

Descriptive statistics were calculated, including means, standard deviations, 95% confidence intervals (95% CI), and frequencies. Interrater reliability and intrarater reliability were estimated for continuous measurements using the intraclass correlation coefficient ($ICC_{2,1}$). The $ICC_{2,1}$ values were interpreted using the criteria advocated by Portney and Watkins.[15] This model was selected because single measurements from randomly assigned multiple raters were used in the study procedure. Interrater and intrarater agreement for nominal datum were assessed using Cohen's Kappa (κ). Minimum detectable change outside the 95% confidence interval (MDC_{95}) was used to assess sensitivity to change as described by Kovacs and colleagues.[16] The MDC_{95} was calculated using the equation standard error of measure (SEM) x 1.96 x $\sqrt{2}$, where SEM is given as the pooled measurement standard deviation multiplied by the square root of 1 minus the measurement reliability. Coefficient of variation was calculated as the grand standard deviation divided by the grand mean for each shoulder. The PASW 18.0 for Mac (Chicago,

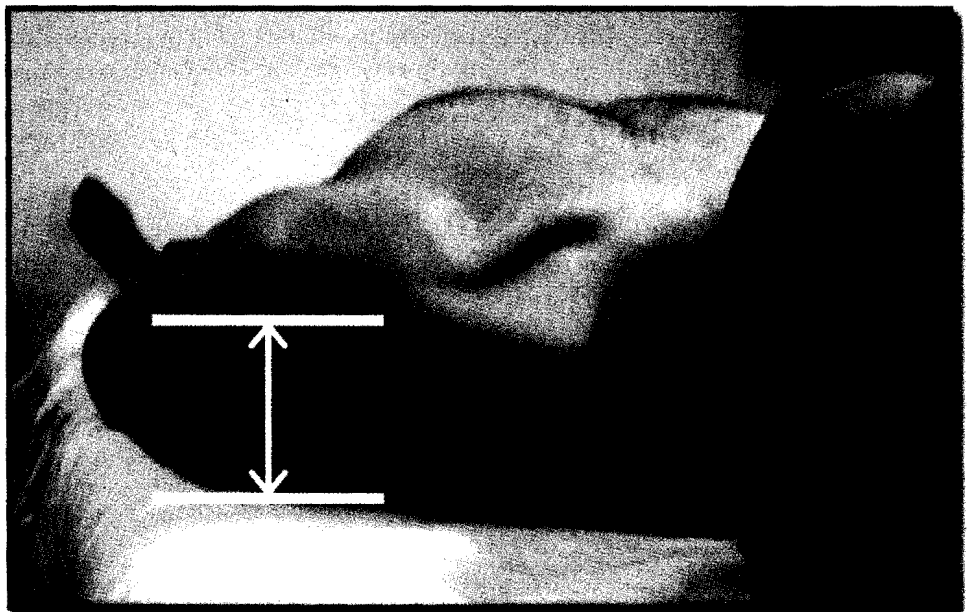

Figure 1. Posterior acromion to table distance under study. Measurements were made using the distance between the lateral-most expanse of the acromion process and the treatment table.

IL, USA) was used for all data analyses. For all analyses, differences were considered statistically significant at $p < 0.05$.

RESULTS

Descriptive Statistics

Mean measurements for the dominant and nondominant shoulders were 7.6 ± 2.0 cm and 7.5 ± 2.1 cm, respectively, for trial #1. Mean measurements were 7.4 ± 2.0 cm and 7.4 ± 2.3 cm for the dominant and nondominant shoulders, respectively, for trial #2. Tightness was identified for 85% to 86% of all shoulders, with the remaining shoulders classified as "not tight."

Relative Reliability

Intrarater reliability for the posterior acromion to table measurement was .751 (95% CI: .628-.861) for the dominant shoulder and .764 (95% CI: .645-.869) for nondominant shoulders. Interrater reliability for the posterior acromion to table measurement was .651 (95% CI: .445-.876) for the dominant shoulder and .733 (95% CI: .548-.911) for the non-dominant shoulder. Percent agreement within raters was 94% and agreement between raters was 90% for the categorical interpretation of the measurement.

Absolute Reliability

The coefficient of variation for dominant shoulders was 25.8% for dominant shoulders and 28.4% for nondominant shoulders. The SEM was 0.99 cm for dominant shoulders and 1.01 cm for nondominant shoulders. The MDC_{95} was 2.74 cm for dominant shoulders and 2.80 cm for nondominant shoulders.

DISCUSSION

This study was conducted to determine the reliability of a common passive shoulder protraction measurement. Because passive shoulder protraction does not appear to discriminate between individuals with and without shoulder pathologies, nondisabled individuals were selected for study. The categorical interpretation of the passive shoulder protraction measurement under study demonstrated very high interrater and intrarater agreement. By contrast, the continuous measurement of passive shoulder protraction demonstrated greater variability and lower interrater and intrarater reliability. The results of this study may be considered a lower limit of reliability, considering the clinical inexperience of the observers that was appropriate for their stage of didactic training, brief training in the measure that observers received, and the relatively high number of observers involved in this study. Previous studies of passive shoulder protraction measurements have demonstrated favorable construct validity with regard to cadaveric measurements and computerized 3-dimensional measurements of scapular position.[9,13] The mean and range for continuous measurements reported in this study are in line with ranges from a previous report.[14]

Although this study contributes meaningfully to our understanding of muscle length testing of the shoulder girdle, particularly for student physical therapists, several research questions as yet remain unaddressed. This study was not designed to assess reliability among practicing clinicians. It is possible that a cohort with greater clinical experience, specifically involving the integration of passive shoulder protraction measurements into practice, could demonstrate higher reliability estimates than observed in this study. The prevalence of normal findings was very low in this study's convenience sample, and normal findings were not independently verified. This study should be repeated in populations that are purposefully recruited to represent the broad range of shoulder protraction measurements. The clinical relevance of passive shoulder protraction measurements are an emerging area of interest.[9] However, this study was not designed to assess the clinical relevance of the measure. Despite these limitations, this study's findings may be used for sample size calculations that can ensure appropriately powered studies to address these remaining research questions. Future studies based on the present report hold promise to continue to improve clinical decision-making and outcomes associated with nonsurgical intervention for shoulder pathology.

CONCLUSION

The posterior acromion to table measurement demonstrates excellent interrater and intrarater agreement when interpreted as a categorical measure, as well as good interrater and intrarater agreement when interpreted as a continuous measure. These data combine with prior findings to support clinical and research application for this passive shoulder protraction measurement.

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