Assessment of Scapular Position

Lynne Meiers and Teddy W. Worrell

Assessment of posture is an integral component of the evaluation of patients with neck and shoulder dysfunctions. Protraction of the scapulae has been postulated to produce weakness of the shoulder musculature. Therefore, an accurate method is needed to assess scapular position in order to determine the effect of therapeutic intervention and classify dysfunction. The purpose of this study was to determine if an experienced clinician would accurately determine scapular position. Fifty subjects (age = 26 ±5.7 years, weight = 69.2 ±14.09 kg; height = 173.9 ±13.91 cm) participated in this study. The results revealed the following reliability coefficients: scapular distance (SD) intraclass correlation coefficient (ICC) = .30, scapular size (SS) ICC = .96, and normalized scapular abduction (NSA) (SD/SS) ICC = .34. These data demonstrate that NSA was not reproducible in this study. The authors hypothesize that NSA contains more measurement error because NSA is a ratio value in which both the numerator and denominator contain measurement error. Further study is needed before NSA values are used to determine scapular position or correlated NSA is used to force development of shoulder musculature.

The relationships between bony alignment, muscle length, and movement have been postulated as important factors in musculoskeletal pain syndromes (3, 5, 6, 7, 8, 9, 13, 15). Kendall and McCreary (7) hypothesize that muscle weakness or shortness may cause faulty alignment, and faulty alignment may give rise to "stretch weakness" or "adaptive shortness" of muscles. Stretch weakness implies that muscles that are in lengthened positions will become weak. In addition, Kendall and McCreary theorize that weakness of the scapular adductor muscles may result in scapular abduction. Because these relationships are often used as a theoretical basis for treating patients with poor posture and neck and shoulder dysfunction, it is important that an accurate and reliable method to measure bony alignment is available to the clinician (7). Reliable methods for determining scapular position will allow clinicians to classify the degree of scapular abduction and the effect of therapeutic intervention, which should correct the dysfunction.

Worrell is with the University of Indianapolis Krannert Graduate School of Physical Therapy, 1400 E. Hanna Ave., Indianapolis, IN 46227. Neiers was a graduate student at the University of Indianapolis Krannert Graduate School of Physical Therapy at the time of this study and is now with Community Hospital East, Indianapolis, IN 46219. Direct correspondence to Teddy W. Worrell.
Goniometric measurements of the upper and lower extremities are widely accepted and highly recommended methods for assessing range of motion (4, 11, 12). A need exists for a reliable and valid method to measure scapular abduction. A literature search revealed only one study that reported reliability of methods to quantify scapular abduction at the scapulothoracic joint (3). Therefore, the purpose of this study was to determine if an experienced clinician would accurately determine scapular position.

Methods

Subjects, Instrumentation, and Procedure

Fifty subjects (22 male, 28 female) with no past or present history of shoulder girdle pain or surgery participated in the study (Table 1). All subjects were right-hand dominant and all measurements were obtained from the right shoulder girdle complex. Prior to participating in this study, each subject signed an informed consent statement approved by a university’s Committee on Research Involving Human Participants.

Scapular measurements were taken with an unmarked section of string to ensure an unbiased measurement. A tape measure secured to a flat surface was used to determine string length.

Each subject assumed a relaxed standing position for 1 min. The examiner (a physical therapist with 7 years of experience) then palpated and marked the spinous process of the third thoracic vertebra with an adhesive tag. The examiner determined the third thoracic vertebra by passively extending the subject’s head. The spinous process that moved away from the palpating finger was labeled C-6, and the examiner palpated down to the third thoracic spinous process (11). The following method as described by DiVeta et al. (3) was used (see Figure 1):

The subject then stood in a relaxed position for 30 seconds before the same examiner palpated the inferior angle of the acromion. The examiner then used an unmarked section of string to measure the distance from the inferior angle of the acromion to the spinous process of the third thoracic vertebrae [sic]. The outstretched piece of string was marked at the site of the inferior angle of the acromion and at the tagged third thoracic spinous process. The

<table>
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<th>Characteristic</th>
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<th>SD</th>
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<td>Height (cm)</td>
<td>173.9</td>
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<td>Weight (kg)</td>
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<td>14.09</td>
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<td>Age</td>
<td>26.1</td>
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*N = 50 (22 males, 28 females).*
linear distance from the third thoracic vertebra to the inferior angle of the acromion was defined as the total scapular distance. (p. 742)

Next, the examiner palpated the medial border of the scapula at the root of the spine and measured the distance from the inferior angle of the acromion to the root of the spine. This linear distance was defined as scapular size (Figure 1). The markers were removed and the entire procedure was repeated by the same examiner after a 1-min rest period. At the completion of the procedure, the marked areas of the string were measured (in centimeters) by a second examiner to determine the total scapular distance (3). The researcher who actually measured the subjects was unaware of measurement values until completion of the testing session.

Researchers obtained normalized scapular abduction values by dividing the total scapular distance from the third thoracic vertebra by the length of the scapula. This was an attempt to normalize scapular size to body size and therefore decrease unexplained variance (3).

Data Analysis

Means, standard deviations, and ranges were calculated for all measured and normalized values. Intrarater reliability for repeated measures for scapular measurements was determined by the intraclass correlation coefficient (ICC 1,1) (10, 14).

The following criteria were used to define the degree of reliability based on our ICC values: .90 to .99 = high reliability, .80 to .89 = good reliability, .70 to .79 = fair reliability, and .69 and below = poor reliability (2). We calculated

![Figure 1 — Scapular position measurements: A shows scapular distance, the distance from thoracic vertebra three (T3) to the inferior angle of the acromion. B shows scapular size, the distance from the root of the spine of the scapula to the inferior angle of the acromion. Reprinted from Physical Therapy with the permission of the American Physical Therapy Association.](image-url)
the standard error of measurement (SEM) for all data using the following formula: 
\[ SEM = SD \times (1 - r)^{1/2} \], where SD is the standard deviation and r is the correlation coefficient (1). The SEM represents the measurement error associated with repeated measure in the units of the measurement.

Results and Discussion

The means, standard deviations, and ranges for scapular distance, size, and normalized scapular abduction are presented in Table 2. Reliability values ranged from .34 to .96 (Table 3).

The results of this study demonstrate that normalized scapular abduction (SD/SS) had poor reliability (ICC = .34) whereas scapular distance measurements (ICC = .80) and scapular size measurements (ICC = .96) demonstrated good to high reliability. DiVeta et al. (3) reported similar reliability values for scapular distance (ICC = .94) and scapular size (ICC = .85), but they reported significantly higher values for normalized scapular abduction (ICC = .78) than we determined (ICC = .34). Normalized scapular abduction is composed of two values, scapular distance and scapular size. Individually, both scapular distance and scapular size are reliable. Each, however, contains measurement error. We believe that normalized scapular abduction, a ratio value, is less reliable because both the numerator and the denominator contain measurement error. The standard error measurement for scapular distance and size was less than 1 cm (Table 3). The standard error of measurement for normalized scapular abduction was larger and

<table>
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<tbody>
<tr>
<td>Scapular distance (cm)</td>
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<td>Scapular size (cm)</td>
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\[^aN = 50.\]

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<tr>
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<td>Scapular size (cm)</td>
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<td>0.34</td>
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\[^aN = 50. ^bICC = intraclass correlation coefficient.\]
approached almost one standard deviation of the mean. This again leads one to the conclusion that normalized scapular abduction contains larger error.

The data of this study support DiVeta et al.'s high reliability in determining scapular size and distance. Our means, standard deviations, and ranges for scapular distance, size, and normalized scapular abduction are very similar to those found by DiVeta et al. (Tables 2 and 4). However, our data sharply contrast with DiVeta et al.'s normalized scapular abduction reliability value (ICC = .34 vs. ICC = .78). Given the similarities of our data (mean, standard deviation, ICC) to those of DiVeta et al., we cannot explain the discrepancy in the reliability of the NSA value. DiVeta et al. (3) reported low correlations between normalized scapular abduction and the following: middle trapezius ($r = .20$), pectoralis minor muscles ($r = .14$), and ratio of middle trapezius force to pectoralis minor muscle force ($r = .01$).

Based on the low ICC value for normalized scapular abduction in our study (ICC = .34), we caution against the use of normalized scapular abduction values to determine scapular position. We feel additional studies are needed to support or refute the reliability of normalized scapular abduction values. As Sahrmann stated in a commentary to the DiVeta et al. article (3, p. 476), "Ratio variables are known to be less reliable than nonratio data." DiVeta et al. did not initially report the normalized scapular abduction reliability, and no description of reliability methods was given (number of subjects, blinding of rater, etc.). We feel confident that the normalized scapular abduction values as measured in our study were not reliable and therefore could not be used to accurately assess scapular position or to make correlations with muscle force. Future studies that attempt to correlate scapular position to muscle force should report reliability of their methods.

**Conclusion**

The measurements of scapular distance and size were found to be reliable when taken by a single examiner in the manner described in this study. Normalized scapular distance, a ratio figure, was not found to be a reliable measurement. Based on the reliability of normalized scapular abduction in this study, further studies should be performed to determine if this measure of scapular position is reliable.

**Table 4**

<table>
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<th>Variable</th>
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*Note. Adapted from DiVeta et al. (1990).*

*a* $N = 60$. 
References