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Reliability of levator scapulae index in subjects with and without scapular downward rotation syndrome

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ABSTRACT

Objectives: The objective of this study was to introduce levator scapulae (LS) measurement using a caliper and the levator scapulae index (LSI) and to investigate intra- and interrater reliability of the LSI in subjects with and without scapular downward rotation syndrome (SDRS).
Design: Two raters measured LS length twice in 38 subjects (19 with SDRS and 19 without SDRS).
Main outcome measures: For reliability testing, intraclass correlation coefficients (ICCs), standard error of measurement (SEM), and minimal detectable change (MDC) were calculated.
Results: Intrarater reliability analysis resulted with ICCs ranging from 0.94 to 0.98 in subjects with SDRS and 0.96 to 0.98 in subjects without SDRS. These results represented that intrarater reliability in both groups were excellent for measuring LS length with the LSI. Interrater reliability was good (ICC: 0.82) in subjects with SDRS; however, interrater reliability was moderate (ICC: 0.75) in subjects without SDRS. Additionally, SEM and MDC were 0.13% and 0.36% in subjects with SDRS and 0.35% and 0.97% in subjects without SDRS. In subjects with SDRS, low dispersion of the measurement errors and MDC were shown.
Conclusions: This study suggested that the LSI is a reliable method to measure LS length and is more reliable for subjects with SDRS.

1. Introduction

Scapular dyskinesis is an alteration of the normal scapular position and the abnormal movement pattern of the scapula (Warner, Micheli, Arslanian, Kennedy, & Kennedy, 1992). The movement pattern in scapular dyskinesis has been associated with chronic shoulder pain in overhead athletes, instability, rotator cuff tears, and impingement syndrome (Burkhart, Morgan, & Kibler, 2003; Forthomme, Crielaard, & Croisier, 2008; Kibler & McMullen, 2003; Kibler & Sciascia, 2010; Ludewig & Cook, 2000; Lukasiewicz, McClure, Michener, Pratt, & Sennett, 1999). Scapular downward rotation syndrome (SDRS), defined as a downwardly rotated scapula with the inferior border being more medial than the superior border (Sahrmann, 2002), has been implicated in scapular dyskinesis related to shoulder pathology and neck pain due to limited neck rotation range of motion (Kibler & Sciascia, 2010; McDonnell, Sahrmann, & Van Dillen, 2005; Struyf, Nijs, Baeyens, Mottram, & Meeusen, 2011; Van Dillen, McDonnell, Susco, & Sahrmann, 2007). A variety of mechanisms related to SDRS are already described in previous studies; in particular, weakness of the upper trapezius and shortness or stiffness of the levator scapulae (LS) are well understood (Sahrmann, 2002; Van Dillen et al., 2007). Increased LS muscle stiffness or shortness may contribute to increased compressive load and shear force on the cervical spine during active neck and shoulder abduction movement (Behrsin & Maguire, 1986; Szeto, Straker, & Raine, 2002). These changes in the LS may lead to abnormal scapular movement or force distribution about the glenohumeral joint, which may manifest as pain, decreased range of motion, or impairment of muscle performance or motor function (Behrsin & Maguire, 1986). Thus, LS length should be measured in the examination and evaluation to determine the effectiveness of intervention for patients with SDRS or other scapulothoracic pathologies.

Previous investigators used x-ray assessment to measure the relative LS length at different shoulder abduction angles (Behrsin & Maguire, 1986). Because the LS originates from the dorsal tubercles of the transverse processes of cervical vertebrae one to four (C1 to C4) and inserts on the superior angle and adjacent medial borders

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of the scapula, the relative distance of the C1 transverse process to the superior angle of the scapula was measured for the shoulder actively abducted at 0, 90, and 170°, and these figures were corrected by dividing by the x-ray distortion factor. However, this LS length measurement method had several disadvantages. First, it was not subject to measurement, mainly because x-ray measurement involves radiation and distortion problems (Berthonnaud, Dimnet, & Hilmi, 2009; Steffen et al., 2010; Suzuki et al., 2010). Second, although the investigators used reference points similar to those in the present study, they did not normalize the LS length through body height. Previous studies have also suggested that muscle length measurement (pectoralis minor) should be normalized to patient height to determine the relative length of muscle (Borstad, 2008). Third, the investigators did not establish reliability of LS length measurement or investigate subjects with SDRS. Clinicians should have access to clinically meaningful measurement tools that are easily accessible.

To be clinically meaningful, LS length reliability statistics need to include a combination of intraclass correlation coefficients (ICCs), 95% confidence interval (CI), and standard error of measurement (SEM) (Valentine & Lewis, 2006). Reliability data on LS length could provide us with information about the amount of error inherent in its measurement, which is valuable for clinicians because it provides guidance to determine whether the measured change is due to measurement error or to real change (Valentine & Lewis, 2006). The purpose of this study was to introduce an objective LS measurement method using a caliper and levator scapulae index (LSI) and to investigate intra- and interrater reliability of the LSI in subjects with and without SDRS. We hypothesized that the LSI would show good to excellent intra- and interrater reliability in both groups of subjects.

2. Methods

2.1. Subjects

A total of 38 subjects (19 with SDRS and 19 without SDRS) volunteered for the study. The subjects were recruited from a university. Descriptive characteristics of the study population are presented in Table 1. All measurements were performed on the dominant side for each subject, defined as the arm that the subject preferred to use for eating and writing. Exclusion criteria for all subjects were a history or clinical exam revealing pain or dysfunction that substantially limited shoulder motion or resulted in gross instability of the shoulder during daily activities, signs and symptoms of cervical pain, adhesive capsulitis, thoracic outlet syndrome, a current complaint of numbness or tingling in the upper extremity, and scoliosis. The group was determined using a visual assessment and a caliper. A positive value was defined as SDRS. The details of scapular downward rotation syndrome measurement were described as follows. A principal investigator (JHL) with 10 years of clinical experience underwent a 5-hour training session before conducting the clinical orthopedic examinations. Before participation, the subjects provided written informed consent. The investigation was approved by Yonsei University Wonju Institutional Review Board.

2.2. Scapular downward rotation syndrome measurement

SDRS was confirmed in this study by a visual assessment and a caliper. A 30 cm metric caliper with 0.1 mm resolution was used to measure the SDRS measurement (Hogetex, Varsseveld, The Netherlands) (Choi, Jeong, & Cynn, 2014). Subjects were standing with their arms relaxed by their sides. With a pen, the rater marked three anatomical landmarks that included (1) the root of the scapular spine, (2) inferior angle of the scapula, and (3) the second and seventh thoracic spinous processes. Amounts of scapular rotations were calculated using the following equation: distance between the thoracic spinous process and spine of the scapula minus the distance between the spinous process and inferior angle of the scapula. Positive values refer to SDRS (Fig. 1) (Choi et al., 2014). This study measured intra- and interrater reliability in subjects with SDRS. The ICCs (3.2) of intrarater reliability were 0.88–0.96 (95% CI: 0.70–0.98, SEM: 0.02–0.05 cm, minimal detectable change [MDC]: 0.05–0.14 cm). The ICC (3.2) of interrater reliability was 0.85 (95% CI: 0.63–0.94, SEM: 0.04 cm, MDC with 95% CI: 0.11 cm).

2.3. Levator scapular length measurement by levator scapulae index

All testing procedures were performed in the standardized position with the subjects standing with their arms relaxed at their sides and their feet shoulder width apart. The subjects were instructed to look directly ahead without craniocervical movement. Any such movement deviating from a neutral head and neck position would influence LS length because the LS is the muscle attached between the cervical spine and the scapula. Furthermore, to neutralize variations of muscle length resulting from respiration, the subjects were asked to exhale and hold their breath before the measurement and to inhale again after the measurement. The principal investigator confirmed the neutral position of the craniocervical spine in three planes (frontal, sagittal, and horizontal) before each measurement. For the anthropometric measurement of LS length, we modified the protocol of Behrsin and Maguire (1986). The instruction was to palpate two anatomical reference points in line that represent LS length: (1) the dorsal tubercles of the transverse processes of the second cervical vertebrae and (2) the superior angle of the medial borders of the scapula (Fig. 2). Before

Table 1
Descriptive characteristics of the study population.

	Subjects with SDRS (n = 19)	Subjects without SDRS (n = 19)
	Mean ± SD	Mean ± SD
Age (years)	19.82 ± 1.60[a]	22.47 ± 3.64
Height (cm)	167.94 ± 6.85	169.00 ± 1.00
Weight (kg)	56.53 ± 6.47	63.21 ± 11.68
Body mass index (kg/m^2)	19.99 ± 1.50	21.97 ± 2.29
Amounts of SDRI (cm)	1.05 ± 2.55	−0.69 ± 1.05

Abbreviations: SDRS; scapular downward rotation syndrome, SDRI; scapular downward rotation index.
Scapular downward rotation index was calculated using the equation: distance between spinous process and spine of the scapula − distance between spinous process and inferior angle of scapula.
Positive values mean downward rotation and negative values refer upward rotation.
[a] Mean ± standard deviation.