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Original article

Interrater and intrarater reliability of the pectoralis minor muscle length measurement in subjects with and without shoulder impingement symptoms

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ABSTRACT

Measuring the pectoralis minor muscle length (PML) is of clinical interest, as a short PML has been associated with a decrease of scapular posterior tilting and shoulder pain. However, as no reliability data are available at present, the objective of this study was to examine the inter- and intrarater reliability of the PML measurement in both subjects with and without shoulder impingement symptoms (SIS). Therefore, two assessors performed the PML measurement (3 times/shoulder) in 25 patients with SIS and 25 pain-free controls. Both assessors were blinded for each other's findings. For reliability testing, intraclass coefficients (ICCs; model 2,1) and standard errors of measurements were calculated. Intrarater reliability analysis resulted with ICCs ranging from 0.87 (Standard error of measurement (SEM) 0.21–0.27%) (symptomatic) to 0.93 (SEM 0.19–0.30%) (asymptomatic) in patients with SIS, representing excellent test-retest agreement. Healthy subjects presented with ICCs ranging from 0.76 (SEM 0.29–0.32%) (dominant side) to 0.87 (SEM 0.21–0.32%) (non-dominant side), representing good test-retest agreement. ICCs and SEMs on the symptomatic and asymptomatic side (0.48 and 0.46%; 0.56 and 0.61%) in SIS patients, and on the two sides (non-dominant; 0.47 and 0.45%, dominant; 0.53 and 0.38% respectively) in healthy subjects showed moderate interrater reliability and low dispersion of the measurement errors. We concluded that the PML measurement has good to excellent intrarater reliability and poor to moderate interrater reliability.

1. Introduction

Shoulder pain is a highly reported musculoskeletal disorder (Luime et al., 2004), in which up to 40% suffer from shoulder impingement symptoms (SIS) (van der Windt et al., 1995; Luime et al., 2004; Lewis, 2009). A variety of mechanisms that relate SIS to posture are already described in the literature, such as forward head posture, scapular protraction, humeral internal rotation and increased thoracic kyphosis (Borstad, 2006). Scapular protraction is defined as scapular anterior tilting together with scapular internal rotation. This deviation is proposed to reduce the subacromial area and has regularly been associated with SIS (Struyf et al., 2011). Measuring scapular protraction as the distance between the most posterior border of the acromion and the examining table has previously demonstrated to be a reliable tool for clinical practice (Nijs et al., 2005; Lewis and Valentine, 2007; Struyf et al., 2009). However, due to its lack of specificity, a direct measurement of the pectoralis minor muscle (PM) length was proposed (Lewis and Valentine, 2007; Struyf et al., 2012). Tate et al. proposed an alternative method for assessing the PML (Tate et al., 2012). Although they used the same reference points as in the present study, they normalized the PML through clavicular length instead of body length.

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The PM originates on ribs 3 to 5 and inserts on the medial inferior border of the coracoid process. Because of this anatomical position of the PM, shortening can lead to an increase in scapular anterior tilting and internal rotation and a decrease in scapular upward rotation, which can be a predisposed condition for SIS (Borstad and Ludewig, 2005; Muraki et al., 2009). In contrast, the PM is lengthened during active upward rotation, external rotation and posterior tilting of the scapula (Borstad and Ludewig, 2005, 2006; Borstad, 2006; Muraki et al., 2009). The association between these deviations and shoulder pain is based on the theory that prolonged positional changes lead to soft tissue elongation on one side of the joint and shortening on the opposite side (Borstad, 2006). Thus a prolonged exposure to a protracted shoulder position could be associated with a shortened PM length (Borstad and Ludewig, 2006). In addition, it is speculated that the PM length is potentially shortened due to repetitive use of that muscle, often seen on the dominant side in overhead athletes (Cools et al., 2010; Tate et al., 2012; Harrington et al., 2014). These side-to-side differences might be the result of adaptive changes in the muscle tension of the PM due to repetitive use of that muscle during overhead activities.. Whether a decreased resting length of the PM is the cause or consequence of changed scapular kinematics is yet to be established (Borstad and Ludewig, 2005, 2006) In view of these studies, coaches and physiotherapists are encouraged to include PM length stretching for the prevention of SIS.

A measurement technique of the PM is validated by Borstad and Ludewig (2005) on human cadavers and by Borstad (2006) both in vitro and in vivo. Measuring the PML by means of a measuring tape or caliper was proven valid in subjects without a history of shoulder pathology. However, reliability of the PML measurement is yet to be established in patients with shoulder pain. Clinicians should have access to clinical meaningful measurement tools that are easy accessible. To be clinically meaningful, PML reliability statistics need to include a combination of intraclass correlation coefficients (ICCs), 95% confidence intervals (CIs), and standard error (SE) of measurement (Valentine and Lewis, 2006). Reliability data on the PML could provide us with information about the amount of error inherent in its measurement, which makes is valuable for clinicians because it provides guidance as to whether the measured change is due to measurement error or to real change (Valentine and Lewis, 2006; Kottner et al., 2011). The purpose of this study was to investigate the reliability of the PML measurement in patients with and without SIS.

2. Materials and methods

This interrater and intrarater reliability study was performed following the Guidelines for Reporting Reliability and Agreement Studies (GRRAS) (Kottner et al., 2011).

2.1. Subjects

A total of 50 subjects (25 SIS patients and 25 healthy subjects) volunteered for the study. Descriptive characteristics of the study population are presented in Table 1. Patients were recruited through physicians or orthopedic surgeons working in private hospitals or private medical practices, located in Belgium and the Netherlands, between February and April 2012. During the same period, participants without shoulder pain were recruited among students of physiotherapy at the Artesis University College Antwerp, Belgium.

The inclusion of patients with SIS was based upon the following criteria: (1) age over 18, (2) shoulder pain present for at least 15 consecutive days (3) a pain score of at least 10% on a Visual Analogue Scale (VAS), a score of at least 10% on the Shoulder Disability Questionnaire (SDQ), and at least 2 out of 3 impingement tests had to be positive for inclusion (Hawkins test, Neer test & Jobe test were performed). Healthy controls were recruited by the following inclusion criteria: (1) age over 18, (2) the absence of shoulder pain (<5% on VAS or SDQ) during the last year and (3) the absence of a history of fractures, treatment or surgery of the shoulder girdle. General exclusion criteria were: (1) the inability to communicate using the Dutch language, (2) presence of a systemic disease, influencing shoulder pathology, (3) pregnancy, (4) traumatic shoulder pathologies and (5) shoulder pain radiating from the cervical spine.

Table 1
Descriptive characteristics of the study population (SD = standard deviation) (abbreviations: y = years; SD = standard deviation).

	Patients with shoulder impingement symptoms ($n = 25$)	Subjects without shoulder impingement symptoms ($n = 25$)
Age (y)		
Mean (SD)	50.8 (16.3)	20.8 (1.5)
Gender		
Male	8 (32%)	16 (64%)
Female	17 (68%)	9 (36%)
Height (cm)		
Mean (SD)	169.2 (9.9)	175.7 (9.8)
Body weight		
Mean (SD)	74.5 (15.5)	72.6 (13.7)

All subjects were informed about the purpose and design of the study and gave their written informed consent. Subjects were free to withdraw from the study at any time. The study protocol was reviewed and approved by the Medical Ethics Committee of the University Hospital Brussels (ref: BUN B143201214180).

2.2. Research design

Prior to the study, 2 raters (JG; FN; Bachelors in physiotherapy with 1 year of clinical experience) underwent a 2-hours training session. This session was supervised by 1 physiotherapist with 9 years of clinical experience (FS; Master and Doctoral degree in sports physiotherapy). The training session instructed the raters in performing an accurate measurement of the PML, including a pilot testing on 8 healthy subjects (not included in data analysis).

First, the subjects' body weight and body height were measured. Next, both shoulders were measured 3 times by each rater. The order of testing (between all 6 measurements and for the choice of assessor) was randomized by coin toss. First the order of rater was tossed, next the order of sides. Successively, both shoulders were tested independently. Both raters were blinded for hand dominance, the affected side (in case of shoulder pain patients), SDQ and pain-scores, and to the outcome of each other's findings. In order to assure blinding, each assessor left the examining room when the other assessor performed an assessment. In order to detect the exact location of the coracoid process and rib 3,4 & 5, palpation was used.

2.3. PML measurement procedure

For the anthropometric measurement of the PML, we adapted the protocol of Borstad (2008), as previously described by Cools et al., (2010). The instruction was to palpate two anatomical reference points which in line represent the PML: (1) the inferomedial aspect of the coracoid process and (2) the caudal edge of the fourth rib at the sternum (Fig. 1). The distance between these two bony reference points was measured with a Vernier caliper (Hogetex, Varsseveld, The Netherlands, 0–300 mm). Both assessors were