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Original article

Validation of the pectoralis minor length test: A novel approach☆

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ABSTRACT

Introduction: Pectoralis minor (PM) shortness is believed to promote faulty shoulder mechanics including reduced scapular posterior tilt. A pectoralis minor length (PML) test that measures the acromion-table distance with and without manual pressure on the coracoid process is supposed to examine the passive mechanical properties of the PM. A threshold for "shortening" has been set at 2.6 cm, but data regarding its validity are lacking. We hypothesized that, under conditions of good reliability, an evaluation of the effect of PM tenotomy, could adequately investigate the construct validity of this test.

Methods: Sixteen subjects with anterior shoulder instability who were undergoing open Latarjet procedures were recruited. We performed the PML test with and without pressure (1) in a clinical setting to check for intratester reliability and setting comparability and (2) in an intraoperative setting immediately before and after PM tenotomy to assess the construct validity.

Results: The PML test exhibited excellent intra-tester reliability (intracorrelation coefficients, ICC > 0.94) and reasonable setting comparability (ICC 0.31–0.54). The change following intraoperative PM tenotomy was significant ($p < .008$) but small (mean = 0.46–0.50 cm) compared to the measurement variability (standard deviation 1.0–1.5 cm). In 12 of the 16 subjects, the measurements remained above the threshold of 2.6 cm.

Conclusions: The influence of the PM on the PML test seems to be minor compared to other factors that cause high measurement variability. A threshold of 2.6 cm cannot distinguish between short and normal PMs. Our findings suggest that the impact of the PM on restricted scapular posterior tilt might be smaller than believed.

1. Introduction

Adaptive shortening of the pectoralis minor (PM) has been associated with shoulder pain in athletes (Reeser et al., 2010; Harrington et al., 2014) and altered scapula kinematics indicative of decreased scapular posterior tilt and increased internal rotation compared to normal arm elevation (Borstad and Ludewig, 2005). There is strong clinical interest in reliable and valid tests that are able to detect and quantify PM shortness because this shortness is believed to promote faulty shoulder mechanics. For a multidimensional assessment of muscle length the following three components should be included: a measurement of muscle extensibility, a quantification of the applied force/torque, and information about the cross-sectional area (Weppler and Magnusson, 2010). In the literature, mainly two pectoralis minor length (PML) tests can be found.

One test is a direct measurement of the resting PML with a vernier caliper (Borstad, 2008). This measurement has been validated in human cadavers with help of electromagnetic tracking system (Borstad, 2008). In addition, good to excellent intra-tester reliability as well as moderate inter-tester reliability was reported (Struyf et al., 2014). However, it remains questionable whether the actual resting length of the PM provides an accurate measure of muscle extensibility (Hrysomallis, 2010; Weppler and Magnusson, 2010).

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Sahrmann (2002) described another clinical test with and without manual pressure on the coracoid process (CP) that is intended to measure PML indirectly through assessing the distance of the posterolateral acromion to the table. Moving the CP manually has been shown to be able to elongate the PM up to the same amount as a 150° shoulder flexion position (Muraki et al., 2009). Therefore, this test could possibly provide indirect information about PM extensibility. If the applied force is quantified, an indirect length–force curve could be assessed that enables the calculation of the passive mechanical properties of the PM (Weppler and Magnusson, 2010). Concerning the PML test without pressure, previous studies have demonstrated excellent intra-tester and inter-tester reliability and reported intracorrelation coefficients (ICC) above 0.90 (Lewis and Valentine, 2007) and 0.88 (Nijs et al., 2005), respectively. However, the diagnostic accuracy of the threshold for a "PM shortness" of 1 inch (2.6 cm) has been questioned (Lewis and Valentine, 2007). Although no data regarding the test's validity are available, this test is used in the literature as an assessment for PML (Sahrmann, 2002; Lewis and Valentine, 2007; Matthew McClain et al., 2012; Shahidi et al., 2012) and as a measurement of forward scapula posture (Nijs et al., 2005; Wong et al., 2010; Struyf et al., 2011). Therefore, whether the PML test truly measures PML, and the extent to which other potential factors, e.g., scapulothoracal structures or the table itself, influence this test, remain unclear. To investigate the construct validity of the PML test, we hypothesized that, following the most extreme treatment of PML, which is the release (i.e., tenotomy) of the PM insertion at the CP, the assessed indirect length/force curve would be substantially less steep and/or shifted toward the right, which would reflect a loss of tissue resistance. Additionally, the measurements after PM tenotomy must be smaller than the threshold of 2.6 cm to indicate "no shortness". Within the Latarjet procedure, which is an established operative treatment for anterior shoulder instability with secondary bone loss of the anterior glenoid rim (Latarjet, 1954), the complete tenotomy of the PM is realized due to the later transfer of the CP. This process allows for the intraoperative evaluation of the immediate effect of PM tenotomy on the PML test. To our knowledge no data on assessing the construct validity of a muscle length test through intraoperative tenotomy are available. As the conditions intraoperative are different from clinical testing a good reliability and reasonable setting comparability are preconditions to interpret the results for clinical use. Therefore, the aim of the study was (1) to assess the reliability of the PML test in a clinical and intraoperative setting including setting comparability and (2) to investigate the construct validity through evaluation of the effects of PM tenotomy on the test results at different amounts of applied force.

2. Methods

2.1. Subjects

Subjects were recruited through the orthopaedic hospital at which the study was conducted. All subjects had symptomatic anterior shoulder instability and were scheduled for an open Latarjet procedure. The Latarjet procedure is a routine surgical procedure for anterior shoulder instability with secondary bone loss of the anterior glenoid rim (Latarjet, 1954; Meyer et al., 2013). The criterion for inclusion was a minimum age of 18 years. The criteria for exclusion included a history of fracture in the shoulder region, shoulder surgery within the last 6 months, scoliosis and neurological disease. All subjects were informed about the procedure and provided written informed consent. The permission of the Ethics Committee of the Canton of Zurich was granted (KEK-ZH: 2013-0349).

The sample size calculation using a 2-tailed power analysis using the data of Wong et al. (2010) (PML test with mean change of 0.65 cm; standard deviation (SD), 0.78 cm) revealed 16 recruited subjects to be sufficient.

2.2. Procedure

The study procedure is summarized in Fig. 1.

Because the amount of force that physiotherapists apply when measuring muscle length can vary widely (Harvey et al., 2003), we used a handheld dynamometer (MicroFET device, Force Evaluating and Testing, Hoggan Health Industries Inc., West Draper, Utah) to quantify this force. Prior to our study, we determined the clinically relevant force by collecting data regarding the forces applied by 10 physiotherapists (with an average of 5 years of clinical experience) performing the PML test. The calculated average of 85 Newtons (N) was fixed as the upper level in our study, and the lower level was set at 65 N for a second measurement.

2.2.1. Reliability and setting comparability

The PML test was performed at most 1 week prior to the operation in a clinical setting and intraoperative immediately before PM tenotomy to investigate the intra-tester reliability and the comparability of the two settings. The testing order was the following: 65 N, 85 N, and 0 N (without pressure) followed by a second repetition for each amount. After the tests in the clinical setting, the subjects' pain and apprehension of instability were recorded using visual analogue scales (VASs) (Price et al., 1983).

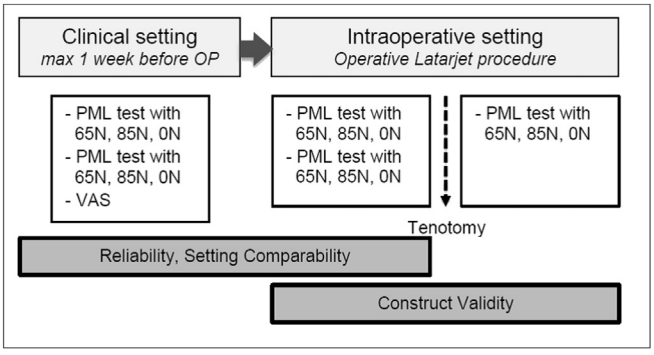
2.2.2. Construct validity

In the intraoperative setting, the PML test was conducted in the same order and immediately before and after PM tenotomy to assess the construct validity. The only intervention between the two measurements was the complete tenotomy of the PM with help of electro-cautery.

2.3. Measurements

2.3.1. Clinical setting

Subjects were in a relaxed supine position with their legs bent and their arms by their sides at neutral rotation. For the PML test without pressure (Fig. 2A), an investigator with 6 years of clinical experience (C.W.) measured the distance of the posterolateral acromion to the table in mm with a metal scale that was positioned vertically. For the PML test with pressure (Fig. 2B), a trained physiotherapist with 13 years of clinical experience (M.E.) applied a diagonal force to the CP (cranial/posterior/lateral). The pressure was controlled with a handheld dynamometer that reported the



N, Newton; PML, Pectoralis minor length; VAS, Visual analogue scale

Fig. 1. Procedure.