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Masterclass

The pectoralis minor muscle and shoulder movement-related impairments and pain: Rationale, assessment and management

Nuno Morais [a, *], Joana Cruz [a, b]

[a] Polytechnic Institute of Leiria, School of Health Sciences (ESSLei – IPL), Department of Health Technologies, Campus 2 - Morro do Lena – Alto do Vieiro, 2411-901 Leiria, Portugal
[b] School of Health Sciences of the University of Aveiro (ESSUA), Campus Universitário de Santiago, Agras do Crasto, Edifício 30, 3810-193 Aveiro, Portugal

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ABSTRACT

The adaptive shortening or tightness of the pectoralis minor muscle (PMm) is one of the potential biomechanical mechanisms associated with altered scapular alignment at rest and scapular motion during arm elevation (scapular dyskinesis) in patients with shoulder complaints. This masterclass briefly reviews the role of the PMm in shoulder movement-related impairments and provides a critical overview of the assessment of PMm tightness and the conventional approaches to increase its resting length and extensibility. A rehabilitation approach focused on PMm stretching and simultaneous optimization of the kinematic chain of arm elevation is also discussed, hoping to improve the management of shoulder movement-related impairments and pain.

1. Introduction

Pain and disability of the shoulder complex are common reasons for seeking musculoskeletal and sports physical therapists. Most often pain and disability are associated with movement; thus, correcting movement related-impairments is considered a key strategy for achieving optimal outcomes (Ludewig, Lawrence, & Braman, 2013). Abnormal scapular position and motion, commonly termed as scapular dyskinesis or scapular dysfunction, may contribute to alter the amount and the precision of shoulder movements, and be the cause or the consequence of pain and functional loss in patients with glenohumeral pathologies such as shoulder impingement, rotator cuff tendinopathy or tears, and adhesive capsulitis (Ludewig & Reynolds, 2009; Ratcliffe, Pickering, McLean, & Lewis, 2014). The adaptive shortening or tightness of the pectoralis minor muscle (PMm) has been considered as one of the potential mechanisms for altering scapular kinematics (Ludewig & Reynolds, 2009), hence addressing PMm tightness is often considered in rehabilitation programs aiming to improve shoulder function and pain. Yet, clinicians' ability to assess and treat PMm tightness has been limited by the challenges of its anatomical location and function.

The aim of this masterclass is to outline a kinesiopathologic and, therefore, a rehabilitation approach for the management of PMm tightness in shoulder movement-related impairments and pain. Firstly, the most relevant literature relating PMm tightness to shoulder pathologies with focus on scapular dyskinesis will be reviewed. Secondly, a critical overview of the existing measurement techniques to assess PMm tightness will be performed. Finally, the conventional approaches to improve PMm length and extensibility will be discussed and a more comprehensive rehabilitation approach will be provided.

1.1. Search strategy

For preparing the review components of this masterclass, an electronic literature search was performed in Pubmed database using a combination of the terms “pectoralis minor”, “length”, “short”, “tight”, “stiff”, “stretch”, “posture”, “scapula”, “kinematic”, “pain”, “symptom” in titles and abstracts. All the relevant abstracts were screened by the first author and those not related to posture/movement-related dysfunctions (*e.g.*, pathoanatomic or neurovascular disorders) or PMm length measurement properties or conservative interventions were excluded from the pool of results. References of the remaining articles were also searched for relevant content. Additional online searches were performed in Google

* Corresponding author. Rua Engenheiro Duarte Pacheco, 19C, Fração AC, 3850-040 Albergaria-a-Velha, Portugal.
E-mail addresses: rpgnunomorais@gmail.com (N. Morais), joana.cruz@ua.pt (J. Cruz).

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Scholar using the same aforementioned terms. The last search was run on 21/08/2015. Relevant articles were then read carefully and are presented in the manuscript, whenever appropriate.

2. Pectoralis minor muscle tightness: functional and clinical relevance

Based mainly on observations of the anatomical position and orientation of the muscle fibers, it has been hypothesized that adaptive shortening or tightness of the PMm may contribute to internally rotate, anteriorly tilt and downwardly rotate the scapula, and protract and depress the shoulder girdle (Burkhart, Morgan, & Kibler, 2003; Kendall, McCreary, Provance, Rodgers, & Romani, 2005; Kisner & Colby, 2007; Novak & Mackinnon, 1997; Sahrmann, 2002). Several clinicians conjectured that such relatively fixed forward and downward scapular positioning may place PMm antagonist muscles (*e.g.*, lower trapezius) in an elongated and weakened position, contribute to limit the amount and precision of posterior and elevation movements of the scapula during arm elevation, and be involved in the development or perpetuation of abnormal stress and healing in shoulder tissues (e.g., subacromial tissues) and eventually pain (Burkhart et al., 2003; Cools, Johansson, Cambier, Velde, Palmans, & Witvrouw, 2010; Kibler, Sciascia, & Wilkes, 2012; McClain, Tucker, & Hornor, 2012; Sahrmann, 2002). Although many physical therapists guide their practice by the postural, muscle and movement imbalances model for the management of painful syndromes in the shoulder region (*e.g.*, subacromial pain syndrome) and upper body quadrant, evidence of a kinesiopathologic mechanism of shoulder injuries and pain is yet to be proven (Lewis, 2011). To date, there are no robust longitudinal studies that can validate the kinesiopathologic chain theorized above. Without the ability to follow human subjects prospectively, it is difficult to discern if alterations found in PMm length and scapular kinematics are compensatory or contributory to shoulder movement impairments and pain. A number of cross-sectional studies partially supports the rationale (Borstad, 2006; Borstad & Ludewig, 2005) nevertheless definitive research is required. Fig. 1 summarizes the associations between PMm tightness, altered scapular position and motion, potential changes in glenohumeral arthrokinematics, abnormal stresses in tissues and painful syndromes that have been documented. Each link will be discussed next, considering also local and regional biomechanical factors that may contribute to shorten the PMm. Fig. 1 also serves as a framework to guide the assessment and intervention proposed later in this manuscript.

2.1. Association between repetitive movements or maintained static postures and adaptive shortening of the PMm

The development of PMm tightness has been mostly based on the principle that adaptive changes in the muscle belly will occur over time when the muscle is chronically exposed to repetitive movements of the scapula in forward and downward directions or maintained in a static shortened position for long periods (Borstad & Ludewig, 2005; Borstad, 2006; Burkhart et al., 2003; Kendall et al., 2005; Novak & Mackinnon, 1997; Sahrmann, 2002). There is emerging evidence suggesting that chronic overhead throwing may lead to adaptive shortening of the PMm. In a study aimed to describe the profile of the scapulothoracic position and strength in asymptomatic elite tennis adolescent players ($n = 35$, 19 girls), Cools et al. (2010) found a shorter PMm on the dominant arm when compared with the nondominant arm. McClain et al. (2012) compared the resting scapular position in the sagittal plane of 20 healthy overhead- and 20 nonoverhead-throwing young adult athletes in supine. The authors concluded that shortening of the PMm in the dominant shoulder of the overhead throwers (mostly tennis and baseball players) was the most likely explanation for the greater difference found between sides in the anterior position of the acromion (McClain et al., 2012). Kinematic studies showed that male athletes of several overhead throwing sports have a more protracted and anteriorly tilted scapular resting position in the dominant arm comparatively to their non-dominant arm (Oyama, Myers, Wassinger, Ricci, & Lephart, 2008; Ribeiro & Pascoal, 2013), or the dominant arm of non-athletes (Ribeiro & Pascoal, 2013). Although the primary goal of these investigations was not to study the association between soft tissue adaptations and chronic overhead throwing, the scapular pattern found has been related to a tight PMm (Borstad, 2006; Borstad & Ludewig, 2005). These researches seem to suggest the existence of resting length adaptations of the PMm in response to repetitive powerful scapular protraction movements during throwing, however, without longitudinal studies a cause-effect relationship cannot be established. Other musculoskeletal adaptations in the dominant shoulder of overhead throwers may also explain some of the findings in scapular position and orientation reported above, such as posterior shoulder tightness (Laudner, Moline, & Meister, 2010).

The few prospective studies that have examined changes in the mechanical properties of human muscles after exposure to chronic muscle actions similar to those used during throwing actions (i.e., stretch-shortening cycles), found an increased stiffness (more resistance to passive stretching) of the muscle tissue (Malisoux, Francaux, Nielens, & Theisen, 2006; Fouré, Nordez, & Cornu, 2012). Yet, the effects on muscles resting length were not studied. Further research is warranted to understand whether a change in PMm length and scapular orientation is indeed related to an excessive active tension of the muscle in shortening.

The PMm may also shorten secondary to conditions that approximate its muscular attachments or reduce the range of its operating length. In muscles immobilized in a shortened position, there is evidence that muscle length and extensibility decreases, possibly due to a decline in the protein content and arrangement of the connective tissues in the muscle belly (Gajdosik, 2001). With this in mind, it is expected that local and regional biomechanical factors with potential to decrease scapular upward rotation, external rotation/retraction and posterior tilting relative to the thorax (e.g., strength imbalances of shoulder muscles or upper quadrant posture and mobility) may predispose the PmM to adaptive shortening. Tsai, McClure, and Karduna (2003) observed that, after applying a fatigue protocol to the external rotators of the dominant shoulder, the scapular resting posture of 30 asymptomatic subjects have changed slightly but significantly (up to 4°) to a more anteriorly tilted, internally rotated and downwardly rotated position, a pattern that persisted during arm elevation. Even though scapulothoracic or axioscapular muscles were not assessed in this study, the authors recognized that the strength of the inferior trapezius and serratus anterior muscles may have been affected by the fatigue protocol and, in part, be responsible for the scapular kinematic changes found (Tsai et al., 2003). This possibility gives impetus to the hypothesis that impaired strength of PMm antagonist muscles may change scapular position and motion patterns and mediate its adaptive shortening (Kendall et al., 2005; Sahrmann, 2002). Research is needed to confirm this hypothesis.

A shortened PMm is frequently assumed to be linked with increased scapular protraction/tilting, forward head posture, and thoracic kyphosis, plus impaired mobility of the upper body quadrant. Findings from investigations conducted in asymptomatic