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Review

Scapulothoracic muscle activity and recruitment timing in patients with shoulder impingement symptoms and glenohumeral instability

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ABSTRACT

Background: Various studies have investigated scapulothoracic muscle activity and recruitment patterns in relation to shoulder complaints in different populations, but a consensus review is lacking.
Hypothesis/purpose: To systematically review the state of the art regarding scapulothoracic muscle activity and recruitment timing in subjects with shoulder pain compared to pain free controls.
Study design: Systematic review.
Methods: The search for relevant articles was performed in Pubmed and Web of Science, including Web of Knowledge, using key words related to shoulder pain, scapulothoracic muscle activity or recruitment timing. Articles were included till November 2012. Case-control studies concerning the scapulothoracic region and muscle recruitment using electromyography (EMG) were included. Articles regarding rotator cuff muscles or neck-shoulder pathologies or studies handling a treatment outcome, were excluded. The methodological quality of the articles was assessed using appropriate risk of bias criteria for case-control studies.
Results: A total of 12 articles were included in the systematic review, containing patients with Shoulder Impingement Syndrome (SIS) or glenohumeral instability. In patients with SIS 3 out of 6 articles showed increased upper trapezius muscle (UT) activity, 3 out of 5 studies showed decreased lower trapezius muscle (LT) activity and 3 out of 5 articles showed decreased serratus anterior muscle (SA) activity. Patients with glenohumeral instability showed contradictory results on scapulothoracic muscle activity patterns. In both SIS and glenohumeral instability patients, no consensus was found on muscle recruitment timing.
Conclusion: Patients with SIS and glenohumeral instability display numerous variations in scapulothoracic muscle activity compared to healthy controls. In the SIS-group, the LT and SA muscle activity is decreased. In addition, the UT muscle activity is increased among the SIS patients, whereas no clear change is seen among patients with glenohumeral instability. Although the scapulothoracic muscle activity changed, no consensus could be made regarding muscle recruitment timing.

Contents

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1. Introduction

Shoulder pain is a common complaint in the general population, involving both high level muscle activity, such as in overhead athletes, and low level muscle activity, such as in people performing repetitive, monotonous or static tasks (Rissen et al., 2002; Madeleine et al., 2008; Strom et al., 2009). Lifetime prevalence of shoulder complaints reaches 66.7%, with women more often reporting shoulder complaints than men and increasing with age (Luime et al., 2004; Strom et al., 2009).

The shoulder complex consists of the glenohumeral joint, acromioclavicular joint, sternoclavicular joint and scapulothoracic physiological joint. Passive stability is mainly assured by the joint capsule, ligaments and glenoid labrum and active stability by the surrounding muscles. These muscles are responsible for moving the entire shoulder and providing stability of the humeral head and scapulothoracic region (Mcmahon et al., 1996). The scapulothoracic joint plays a very important role in the mobility and stability of the shoulder complex. Adequate scapular positioning and movement is important to create a stable base for centering the humeral head and channeling force production during daily activities and sport participation (Struyf et al., 2011). An optimal interaction between scapular and glenohumeral muscles is needed in order to achieve large ranges of shoulder mobility and consequently adequate shoulder stability (Struyf and Nijs, 2011). The inability to achieve this stable base has been reported to accompany the development of shoulder and upper limb pathology (Mottram, 1997). An appropriate neuromuscular strategy of contraction is necessary to stabilize and minimize scapular anterior tilt during shoulder elevation. When this neuromuscular pattern is inappropriate, the shoulder could be at risk of developing Shoulder Impingement Syndrome (SIS) (Hebert et al., 2002).

The muscular system is one of the major contributors of scapular positioning both at rest and during shoulder movements. The serratus anterior muscle (SA) and the trapezius muscle are usually considered to be the most important stabilizing and mobilizing muscles of the scapula. The SA is also unique among the scapulothoracic muscles because it has the ability to contribute to all components of the normal three-dimensional movement of the scapula on the thorax during elevation of the arm (Ludewig et al., 1996). This muscle can produce scapular upward rotation, posterior tipping, and external rotation (Ludewig et al., 2004). The SA is also the major protractor of the shoulder girdle (Mottram, 1997) and has a primary function of stabilizing the scapula against the thorax (Schmitt and Snyder-Mackler, 1999; Ludewig et al., 2004). Dysfunction of this muscle (E.g. n. thoracicus longus lesion) results in an internal rotation of the scapula, also referred to as winging (Mottram, 1997; Ludewig et al., 2004).

Knowledge of scapulothoracic muscle activity and recruitment timing can assist clinicians in their preventive and rehabilitation strategies in patients with impingement or instability symptoms. However, the literature currently lacks a systematical overview that provides clinicians insight in normal scapulothoracic muscle activity and possible alterations in patients with shoulder pain. For assessing muscle function, researchers and clinicians often apply surface electromyography (EMG) (Lewis, 2004; Minning et al., 2007). Parameters which are frequently studied are signal amplitude, conduction velocity, fatigability and characteristic frequencies/patterns (Schulte et al., 2006). Objective of this study is to systematically review scapulothoracic muscle activity and recruitment timing measured by EMG in subjects with or without shoulder impingement symptoms or glenohumeral instability.

2. Methodology

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Liberati et al., 2009) statement guidelines were followed. Methods of the analysis and inclusion criteria were specified in advance and not changed post hoc.

2.1. Eligibility criteria

Eligibility criteria were framed by the PICO methodology. Key words were derived from the PICOS-question and were converted to possible Mesh-terms (between brackets) if available.

- Patient(1): shoulder pain, Shoulder Impingement Syndrome, (Frozen Shoulder), Shoulder Bursitis, (shoulder instability), (glenohumeral instability), Shoulder Dislocation.
- Intervention: electromyography, (EMG), (electromyographic).
- Comparison: (healthy subjects), (asymptomatic subjects), (pain free shoulder).
- Outcome(1): scapula, (scapulathoracic), (scapular).
- Outcome(2): muscle recruitment, muscle activity, muscle activation, control, biomechanic(s), activity, kinematic(s), patterns, ratio.

Consequently, all study titles were screened based on the selection criteria mentioned in Table 1. Afterwards, the remaining articles were screened on abstract. In case of missing details in the abstract, full articles were requested and screened for eligibility. In order to give a clear answer on the difference between patients with shoulder pain and pain-free controls, only case-control studies were included in this analysis.

2.2. Information sources

Studies were identified by searching electronic databases and scanning reference lists of articles. Articles had to be written in English language. This search was applied to Pubmed (http://www.ncbi.nlm.nih.gov/entrez) and Web of Science, including